Dr J R Coxe from the author

J. R. Coxe. M.D.

THE

INTRODUCTORY

LECTURE,

OF

THOMAS COOPER, Esq.

PROFESSOR OF CHEMISTRY AT CARLISLE COLLEGE
PENNSYLVANIA.

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WITH

NOTES AND REFERENCES.

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THE OPINION DELIVERED

BY JUDGE COOPER

IN THE HIGH COURT OF ERRORS AND APPEALS OF PENNSYLVANIA,

JULY 29, 1808.

In the case of Dempsie Ass. of Brown *v.* the Insurance Company of Pennsylvania,

ON THE EFFECT OF

A Sentence of a Court of Vice Admiralty, as between the INSURER AND THE INSURED.

With a preface by ALEXANDER JAMES DALLAS, ESQ.

In the Press and speedily will be Published

THE INSTITUTES OF JUSTINIAN

WITH A REVISED TRANSLATION.

And with references to parallel Passages in the CIVIL LAW: THE LAW OF ENGLAND: AND AMERICAN REPORTERS.

BY THOMAS COOPER ESQ. PRESIDENT JUDGE, &c.

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PREFACE.

Some explanation may seem necessary to distant readers, of the character in which I now appear.

In the spring of 1811 the legislature of Pennsylvania, thought fit to disapprove of my conduct as a JUDGE. None of the charges exhibited, were of a nature to induce *me* to disapprove of my own conduct ; or to have altered it in any manner, had I returned to the bench. At length, the governor was addressed for my removal, and the reasons assigned for this measure entitled me as I thought, to the *thanks of the community.* Most certainly, I have repeatedly received voluntary testimonies of approbation, from the most respectable citizens of the district in which I presided, for my behaviour in those very cases, that the legislature thought fit to point out, as instances of misconduct.

This is a government founded on universal suffrage, in which all power centers with the people. They certainly may insist, that their representatives shall not only consult popular opinion, but pay attention even to the piques, the prejudices, and the caprices, of the populace. From the first day of my presiding on the bench, (nearly eight years untill the period of my dismissal) I had taken care, distinctly, and unequivocally to shew, that as a JUDGE, I held what is usually called popularity, in very light estimation ; and the result might have been expected.

I felt resentment at first, at the manifest prejudication of my case : at the party spirit that was destin'd to decide it : at the refusal of public investigation : at the contempt shewn to all the impartial forms of judicial proceeding : at the barefaced violation of the constitution. I was wrong. I ought to have reflected at the outset, from my own knowledge of the world, that all this, would be in the common course of events. A compliance with the constitution, would have been tedious, troub'esome, expensive, and hazardous. Even the spirit of party, might have shrunk before the solemnity of an oath. The legislature knew this ; they wisely took a shorter course, and cut the knot which they could not venture to untie. I persisted I was right, and demanded a trial ; they insisted I was wrong, and refused it : they outvoted me : and all is well.

Under these circumstances, I accepted cheerfully the offer of the chemical chair at the college of Carlisle, in the summer of the same year. It was an honourable addition to the proofs I had already received, that wise and good men, had been content to look at these proceedings, with undiminished confidence in my character; and that I had not forfeited the good opinion of that portion of society, which was best qualified to determine how far I had deserved it.

I delivered the following Lecture, in the capacity of chemical professor, in the beginning of August of the same year. The request of the Trustees to publish it, can only extend to the Lecture itself; but I am not aware that any thing is contained in the notes, that may not properly be offered to the consideration of that class of students who are deemed qualified to attend the lectures of a chemical professor. I added those notes, partly because the dry detail of the lecture itself, seemed to require some miscellaneous additions to give interest to it; partly, because it afforded me an opportunity of introducing some curious, and some useful matter, not unconnected with the subjects of the discourse; and partly I acknowledge, because a wish to see the whole in a form more permanent than that of a fugitive pamphlet, induced me to pay regard to the *justum volumen* But I have not chosen to indulge this, by swelling the book with a translation of the latin passages, presuming that the class of readers for whom it is intended, require no such aid.

I should have done better, if while I composed these notes, I had enjoyed the opportunity of referring to my own library and Dr. Priestley's for many years and still, under the same roof at Northumberland. The want of this advantage, has compelled me to trust much to my own memory, and to take several of the references at second hand. But I have carefully verified every citation, that the library of the College has enabled me to consult; and I have cited without scruple, my second hand authorities, where I could get no better.

Two or three of the extracts, are from publications that I have lately received, and which are not much circulated in this country. I hope the subjects of them, relating to public improvements, may dwell upon the minds of the students here; many of whom are destined, as they deserve, to bear important, parts, in the future politics of this country. They may be the instruments hereafter of much public good: and I have inserted these quotations, in earnest hope, that the bread thus cast upon the waters, may be found again after many days.

In compiling this lecture, I have consulted and used, some authors, who in part, have trodden the same ground.

Olaus Borrichius de ortu et progressu Chemiæ.

Bergman de primordiis Chemiæ.

——— Historiæ Chemiæ, medium ævum.

His dissertation de nuperrimus chemiæ inventis, I have not used.

Dutens, origine des decouvertes attribues aux modernes. 2 V.

Goguet, origine des loix, des arts, et des sciences 3 V in English.

Ameilhon, recherches sur le commerce des Egyptiens.

Crawfurd's sketches of the Hindoos. 2 V. second edition. (anonymous).

Of *Winkelman's* histoire de l'art chez les anciens, I possess but the two first volumes of the late Paris edition, and they gave me no lights.

Watson's preface to his essays, contains a few facts, relating to the history of chemistry, which I have forborn to borrow from so very entertaining and popular a work.

My detail of minerological authors, I owe entirely to *Jameson*.

My remarks on the minerological language of the present day, may seem to require some apology: but as I neither wish nor expect that my own deviations will be treated with less freedom, I am not prepared to make any. In fact, both the science and the language, are yet in a state of infancy; and any attempt to correct and improve, the one or the other, is entitled to consideration. I have lived too long in the political world not to be well aware, that *innovation*, is not always *reformation*. But neither in the world of Politics, or the world of Science, can there be Reformation without it. Every alteration or the better, to a certain degree implies innovation; but experience I acknowledge, will not justify us in saying, that the converse of the proposition is equally true.

THOMAS COOPER.

Carlisle, Pennsylvania,
April 1, 1811.

INTRODUCTORY

LECTURE.

IT hath pleased Providence, to place mankind in such a situation, that great exertion both bodily and mental, becomes necessary, before we can acquire the means of comfortable subsistence, and place within our reach the regular enjoyment of such objects as afford an innocent, as well as a moderate and grateful stimulus to the senses. Many ages, and many arts must concur to supply us with safe and commodious habitations, clean and convenient cloathing, plentiful pleasant and nutricious diet, and the mutual communication of wants and redundancies throughout the Globe. These advantages can only be acquired, by acquiring a knowledge of our own powers and faculties, and of the properties of the beings that surround us, animate and inanimate. It is thus we learn to avoid the noxious qualities of some, and gradually discover to what useful purposes of human existence we can apply the rest. For it was manifestly intended by our Creator, not only that man should have dominion over the fish of the sea, over the fowl of the air, and over every living thing that moveth upon the face of the earth, but over the trees of the forest and the herbs of the field—over the waters that fertilize and embellish the earth—over the light that irradiates it, over the heat that cherishes it, over the atmosphere that animates it, and over the very earth itself, whereon we live move and have our being. We have not yet subjected, and probably never shall subject to our influence the starry host of Heaven; but the discovery even of a few of the laws by which their motions are regulated, has enabled the most distant nations of the earth to hold mutual intercourse, to discover and supply the wants of each other, to create new sources of enjoyment, and extend the interchange of knowledge to the common advantage of the great family of mankind. Nor is it a conjecture improbable in itself, or in any way unworthy the attributes of our Creator, to believe, that this is a dispensation common to the inhabitants of this globe, and to those of the countless succession of planetary systems that fill the regions of infinite space; and that as we profit by the laws that govern their revolutions, so do they by ours: and thus throughout the illimitable range of the universe, each is made subservient to the comfort of all.

Hitherto, after all the efforts of human industry, ingenuity and perseverance, the encrease of knowledge of whatever description, hath served to discover how very little we know in comparison of what remains to be known, and how truly we may consider the most cultivated of the Sciences as yet in its infancy. A discovery, which though some may consider as humiliating to the boasted pride of human genius, affords to me a prospect cheering beyond all calculation. Here opens a field of improvement, and here are objects presented for the exercise of our faculties, that to the mind's eye, seem to have no termination: and though I allow with regret, that the doctrine of human perfectibility must be ranked among the pleasing reveries of philosophy, which sober reason dares not adopt—yet it is not too much to expect, that as the objects of knowledge are inexhaustible, mankind may be permitted through countless ages to come, to proceed in that career which Providence seems to have assigned to them; and though moderately, yet continually adding to the general mass of knowledge, and by means of knowledge, to the general mass of Happiness. We find in fact that it is, and from the first period of the history of every civilized country, that it hath been so; that such hath been the cause, and such hath been the effect. Much as there may be in the present state of human society to lament, who that hath attended to the history of its progress, can hesitate for a moment to allow, that with all its evils, the situation of mankind in the present age, is very far preferable to the time when man was found, as occasionally he is yet found, little removed from the beast of the field in intellect or enjoyment, *propter glandem et cubilia pugnans.* No one can deeply reflect upon this state of society, without being persuaded that virtue as well as happiness arises, not from the paucity, but the multiplicity of our wants; which by multiplying the sources of mutual dependence gives birth to grateful feelings and all the benevolent affections; while knowledge is employed to furnish the means of gratification, and encreases in proportion to the use made of it. There is no virtue and no happiness in a stock or a stone; for they have neither wants nor wishes to be gratified.

But knowledge is a plant of slow growth. "By the "sweat of your brow shall ye eat bread," was the injunction laid upon our first parents according to the testimony of the Scriptures; and how can he have knowledge (saith the wise man) who goadeth the Ox? that is, whose whole time is occupied in manual labour for the purpose of satisfying the necessary wants of life. Hence many ages from the infancy of mankind must have passed away, before any thing like science could have appeared; for science is the deduction of general laws from the induction of a multitude of facts, repeatedly and accurately observed, and carefully noted. The materials of science must have accumulated very slowly and very gradually: much practical knowledge must have existed, before we hear of any attempts to reduce to order the facts known, to explain their connection, to theorize upon their causes, to suggest improvements, and to make the practice of the artist depend upon the knowledge of the Philosopher: and so it hath been. By degrees however the accumulations of industry, produced leisure, and this became the parent of observation, which discovered and registered useful facts; at first by tradition, next by hieroglyphic inscription as in Egypt and Hindoostan, then by alphabetical writing, at present by printing. What further improvement in the methods of communicating and perpetuating knowledge may take place, no happy conjecture I believe, hath yet anticipated. (1.)

The sciences occupied about the appearance and properties of bodies, may be thus classed in a general way.

The past and present appearances of animal, vegetable and mineral substances, with their relation to the places and circumstances under which they are found, but without any reference to the causes that produce these appearances, form the business of what is called NATURAL HISTORY.

The laws of organic life, (certainly distinct from chemical and mechanical forces) are the proper objects of PHYSIOLOGY.

The laws that regulate the phases and motions of the heavenly bodies, belong to the science of ASTRONOMY which strange as it may appear, seems to have been the first study worthy of the name of science, which occupied the attention of mankind. The cloudless atmosphere, and pastoral life of the inhabitants of the eastern countries which in some part or other seem to have furnished the cradle of the human race, were particularly favourable to this kind of observation; and the knowledge resulting, appears to have been subjected to rule and calculation, at some period certainly antidiluvian. The fabulous pretensions of Egyptian, Chinese and Hindoo Chronology are properly rejected by sensible men; but the comparatively moderate periods assigned by Baillie, la Place, and Playfair, seem to rest upon observations too solid to be shaken. (2.)

The laws of inorganic bodies found upon our Globe considered as aggregates or masses, with reference to their size, shape, and weight, the forces acting upon them, and the properties thence resulting, are the peculiar study of MECHANICS; a science which has been practically cultivated in England with astonishing success; and which has contributed not merely to the riches of that country more than any other, but to the comfort of every individual in it, from the meanest habitation thro' every house and workshop, to the most splendid apartment of the Palace. It is to this science in conjunction with chemistry, that the great wealth and power of that nation is principally indebted. (3.)

The laws of inorganic bodies, as to colour, hardness softness, elasticity, solidity, fluidity, specific gravity, penetrability, impenetrability, motion and rest, form the subject of *Physics*, or what in England and this country, we are accustomed to call NATURAL PHILOSOPHY. Frequently this has been considered as including, not only mechanics, but, the doctrine of light (Optics or Photology) and the doctrine of heat or Caloric, as connected with the attractions of gravitation, and cohesion. Treatises on natural philosophy also, usually announce the laws that govern the attraction of magnetism, and the attraction of electricity, common, and galvanic.

The more peculiar objects of CHEMICAL science, are the disorganized and inorganic bodies; not considered as aggregates or masses, but as respects the composition and decomposition of the particles themselves that compose those masses, into two or more of a different nature, by what is called Analysis; and the formation of one set of particles by the intimate union of two or more of a different nature, which is called Synthesis. This is done by mixing bodies together at various temperatures according to the purpose to be effected. This decomposition and composition of bodies, is performed according to the laws of the attraction of combination, or chemical attraction: which notwithstanding the great industry employed in its investigation, particularly of late years, is as yet but very imperfectly known, either as to its cause, connections, or effects, or the precise laws by which it is governed. M. Berthollet has shewn that it greatly depends on the attraction of cohesion, and on the relative masses or quantities subjected to mutual action; and some late experiments of Mr. Davy, have rendered it highly probable that it is in some manner or other, intimately related to electricity; but in this, as in many other respects, we must be content to look at chemical science through a glass darkly, and to consider it for the present as depending upon specific attractions, not reducible to the laws of any other. All these attractions, whether the planetary by which the heavenly bodies are restrained within their orbits; the attraction of Gravity which draws earthly bodies towards the centre of the earth; the attraction of Cohesion by which several particles unite to form an Aggregate or Mass; the attractions of Magnetism, of Electricity and of Combination, are all affected at varying distances, and counteracted, by powers of repulsion attending the same mass, or the same particle. Hitherto, no satisfactory illustration has been given of this general law so far as I know by any Philosopher whatever. Father Boscovich in his *Telluris Theoria Naturalis*, a work as yet remaining untranslated from the original Latin in our language, and by no means sufficiently noticed or known, has made an effort on this subject that deserves a more extensive circulation than it hath yet received. See Suppmt. to Dobson's Edinb. Encyc. Art. Boscovich.

I shall now proceed to illustrate the general remarks I have made on the progress of Knowledge, by applying them particularly to the subject before us; and this will afford me an opportunity to trace something like a History of Chemistry, and shew by what means through the early ages of the world unto the present time, that which was merely an Art, consisting of empirical processes, chiefly confined to the workshops of the manufacturers, put on the appearance and assumed the importance of a Science; not only worthy the most profound investigations of the Philosopher, but so nearly connected with every want and every comfort of social life, affording results so unexpected, and appearances so interesting, that it is no wonder the Science that embraces them, should be studied with an eagerness of application, not likely to be lessened by the encrease of our Knowledge.

I well know, that modern authors on Chemistry, and even the compilers of the most respectable elementary works, decline entering upon the history of the science they profess to teach, as comprehending only a dry investigation of facts, and dates, and names, uninteresting to the student, because almost unintelligible at the outset of his studies; and communicating no practical Knowledge. Hence I am unacquainted with a tolerable History of Chemistry in the English Language. But it appears to me that the History of an Art or Science is a proper introduction to the study of it; especially of Chemistry, as containing æras of discovery intimately connected with controversies yet unsettled, and therefore worthy to be known—as giving a clear and concise view of the manner in which improvements have been effected——as exemplifying the general utility of Chemistry——as furnishing due caution against future errors, by exhibiting the mistakesof superior minds of older times—as rendering merited honour those to who have benefitted mankind by their discoveries—and as comprizing in a connected detail, those periods and gradations of improvement, which would not so distinctly dwell upon the memory, if delivered in an insulated manner during the occasional illustration of some particular experiment. I think it also the more necessary upon the present occasion, because the path I am about to take has not been sufficiently beaten, and deserves in my opinion more investigation than has hitherto been given it.

I propose therefore to enquire what was known of the Chemical Art, in the earliest stages of society as related to us in the Bible; comprehending the detached facts of knowledge among the Jews and the Egyptians. I shall pursue the Chemical attainments of the Egyptians and Phœnicians, partly by means of modern remnants of ancient art, and partly from the relations of ancient authors, principally Herodotus, Diodorus Siculus, and Pliny. It will then fall in with my plan, to treat of Chemical Knowledge among the Greeks and Romans, and briefly to notice the manufactures of China and Hindoostan. The Chemistry of the middle ages, and the discoveries of Modern Europe since the establishment of public societies for the propagation of knowledge, will fill up the Sketch.

I shall begin with the Mosaic relations upon this subject, because whatever objections may have been made to them, they carry marks of internal evidence that entitle them to great consideration, independant of any Theological questions which may be connected with them, and with which in these lectures, I have nothing to do. Moreover the general character and extent of the Mosaic chronology, (adopting the results afforded by the Septuagint (4.) version) bids fairer in my opinion, harmonize with the established and probable facts of profane history, and with the progress of civilization in particular, than any other with which we are acquainted.

We are told then, that Tubal Cain some generations after the Mosaic period of the expulsion of Adam, was the instructor of all those who worked in *Iron* and in *Brass*. Whether the original word here translated Brass, was really meant to disignate that specific mixture of Zinc and Copper, now so called I know not. I doubt it: because the evidence appears to me very strong that little was known of that mixed metal, till the discovery of the three kinds of Orichalcum at Corinth. Brass indeed is repeatedly mentioned in the Old Testament, but I should in all cases call it Copper. The translators of the Scriptures tho' learned men, need not be regarded as expert Chemists. Tubal Cain is supposed to have given origin to the VULCAN(5.) of the Greeks, not only from similarity of name, but profession: but I hesitate about etymological analogies: by learned and ingenious men such as Dr. Swift in jest and Mr. Bryant in earnest, Etymology may be moulded into almost any shape that fancy and ingenuity may think fit to dictate.

That *wine* (6.) from the grape, was an antidiluvian discovery does not clearly appear: it is said, Noah *began* to be a husbandman and planted a Vineyard; nor does he seem to have been sufficiently aware of the effects of this liquor. From his time forward however, it appears to have been a very common beverage both with the rich and the poor, for reasons that seem to me implied in the singular expression in the Fable of Abimelech. Until the time of Isaiah and Hezekiah in whose reign that Prophet flourished, the juice was pressed out, not by machinery but by men's feet: at what time machinery was first, introduced for this purpose among the Israelites, I find no passage that indicates. The regulation of the liquor in a fermenting state, seems alluded to in a passage in Job. The wine appears for the most part to have been made from a red grape.

Chemical practice however must have been in a good state in Egypt in the time even of Joseph. We find him directing his silver cup, to be put into Benjamin's sack. The process of embalming (7.) also, was tedious but seemingly skilful in his time; for the Physicians who embalmed the body of his father Jacob, were employed forty days upon the business. These embalmings, (after taking out the intestines and the contents of the scull, pickling the body in salt and nitre, and drying it) were probably finished by a solution of some of the resins (wherewith Egypt, Arabia and Syria abounded) in the liquid turpentines from the class of Firs: for the resins could not have had an alcoholic solution, distillation being then unknown.

That they were acquainted with *resins* and many of their properties, appears from the composition(8.) of the sacred perfumed oil, directed to be exclusively prepared for religious uses by Moses, from oil impregnated with stacte, onycha, galbanum, frankincense, myrrh, cinnamon and calamus. So also in the first book of Chronicles mention is made of the oil of the spices, which seems to have been the holy perfumed oil, already noticed.

Oil from olives is mentioned in various places in Exodus, Leviticus and Deuteronomy. The Egyptians expressed oil, also form the Sesamum and the Rape seed, but no passage occurs to me of the use of these articles among the Jews. The olive oil was used as a luxury to the person, as an article of food, 8 Lev. 26. and for lamps. This latter use of oil, tho' common to the Jews and Egyptians was not known to the Greeks in Homer's days, probably from the dearness of the article. The fruit was pounded in mortars for the purpose of extracting the oil.

That the resins for embalming were dissolved in liquid turpentine, is further rendered probable, in as much as Pitch (9.) Tar and Bitumen were well known. This appears from many facts that may be referred to : but as the act of rendering oils drying by metallic oxyds was then unknown, as well as the act of distillation, and as rosin (10.) and burgundy pitch could not then have been known for the same reason, and as common pitch was too dark for the purpose, the process of embalming must have been as I have described it, so far as concerns the varnish.

Moses is said to have been skilled in all the learning of the Egyptians: from them doubtless he derived his knowledge of precious *stones* (11.) and *engraving* upon gems: of *dying* (12.) blue, purple, scarlet, and crimson, upon linen the staple commodity of Eygpt. The art of *gilding* (13.) and *plating*, both with silver and gold, appears also to have been known in his time, for wood and baser metals are mentioned as having been covered with these more precious substances, with respect to the golden Calf (14.) which he made the children of Israel to drink, there appears to be some uncertainty as to the process employed. Stahl or Bergman first suggested its solution in liver of sulphur: the Bishop of Landaff (Watson) thinks he filed it. (I refer to his essays.) And professor Michaelis of Gottingen is of opinion, that it was merely gilt wood.

In 18 Gen. 8. Abraham is said to have set before his guests Butter (15.) and Milk, and in 32 Deut. 14. the Butter of Kine, and the Milk of Sheep are mentioned. The art of Bread-making (16.) was well understood in early days, for leavened and unleavened Bread are repeatedly noticed in the Old Testament. The first invention for bruising the grain and making meal, must have been by pounding in a mortar: when mills (17.) were invented does not appear. In 18 Gen. 6. Abraham directs Sarah to knead three measures of fine meal, which Goguet (1 Goguet 104) thinks implies the use of mills: an implication of which I do not see the force. There are however some passages in the Old Testament wherein mention is made of mills, and of millstones.

Soap and nitre, or the mineral alkali, are expressly mentioned by Jeremiah 2 Jer. 22.

Beer was certainly known in Egypt at a very early period; no mention of this beverage occurs in the Scripture books of the old Testament, but Vinegar(18.) was in very common use for this purpose.

I do not find any thing further in the biblical account of chemical facts, worthy of distinct notice. The Jews seem to have had little taste for the arts, which in the time of Solomon were at so low an ebb, that he found it expedient to send for workmen from Tyre. The Luxuries of dress used by the Jewish ladies, are curiously and distinctly enumerated in the latter end of the third chapter of Isaiah; and the twenty-seventh chapter of Ezekiel contains an instructive account of the commerce of Tyre.

I proceed therefore to the chemistry of Egypt and Phœnicia, so far as it can be collected from profane authors and the detached facts of modern observation: and as the knowledge of Egypt and Phœnicia was almost co-extensive in this respect with the knowledge of the antient world, I shall dwell upon it rather at length. Indeed it is somewhat surprizing that the Jews did not profit to a greater degree from the quantity of knowledge of which Egypt was the principal depositary.

(19) Egypt according to the account of ancient authorities was allotted to, and peopled by the descendants of Ham or Cham, and according to Plutarch (de Iside at Osiride Ch. 5) was called Chemia. The antient Scripture name of it was Mizraim. But the actual possession of Egypt by Ham or Cham, and the derivation of Chemia from this son of Noah, rest with me on grounds too slight and fanciful to be implicitly relied on. For the same reason I do not think it worth while to detail the imperfect and ill authenticated facts to be collected from the scattered fragments of Manetho and Sanconiathan, or the unintelligible dogmas attributed to the Egyptian Hermes, (20) or Trismegistus. What we know about the arts of Egypt in ancient times we must gather almost exclusively from Herodotus, Diodorus, Plutarch, and Pliny, and from the modern remains discribed by Pococke, Norden, Savary, Volney, Denon, and Hamilton. All I can do in the present lecture is

to give, not a history but a brief abridgement; not a picture, but a sketch, an outline. I can make some additons however to the collections of modern writers on ancient art.

Glass (21.) appears to have been discovered by some Phœnician sailors, who making use of Turf containing Soda (natron. nitrum) to boil their pots, found the pots vitrified, and the ashes and the sand, run together into the transparent substance we call Glass. According to Pliny this was in very early times. The manufacture was commenced at Tyre, and the sand for the purpose, was chiefly procured from the banks of the Belus, a small river that still runs by St. John D'Acre, and called by the Arabs, Nahr Halou. The art of Glass making, (for two thousand years a source of great gain to Tyre and Sidon) appears to have passed from thence to Egypt, whose inhabitants in the time of Pliny and Diodorus of Sicily, were remarkable for their dexterity in manufacturing artificial Gems, particularly imitations of the Cyanus, (which I take to be not the Sapphire, but the blue Lapis Lazuli) the Smaragdus or Emerald, the Sapphire, the Hyacinth, and the Carbuncle or Ruby, these include blue, red, and green coloured glass. I agree entirely with Bergman and Goguet, that the collossal Serapis of nine cubits high mentioned by Pliny, and the Obelisk of four large emeralds in the temple of Jupiter noticed by Theophrastus, and the transparent hollow column at the temple of Hercules at Tyre mentioned by Herodotus, were not real but artificial Gems, composed of coloured green glass. That large columns of glass were not unknown to the ancients, still further appears from the seventh book of the Recognitions of St. Clement, wherein St. Peter is desired to go into a Temple in the Isle of Arad to see some columns of glass of great size. The recognitions of Clement indeed, like the shepherd of Hermas and the other pious reveries dignified with the title of Apostolic fathers, (translated by Archbishop Wake) are of very slight authority for a theological fact or opinion, but the very mention of a column of this nature, shews that the thing was considered as within the compass of art at that time. Indeed I suspect all these emerald figures of great size, *might* have been glass varnished with a green coating; for coloured varnishes were in use in the process of embalming among the Egyptians. Guyton Morvean has lately ascertained that the large (supposed emerald) Basin, called the Sacro Catino which Buonaparte removed from Genoa to Paris, is coloured glass:

for it is much softer than any genuine emerald, and it contains the defect of glass which workmen call blebs. Rock Chrystal scratches it.

Whether these facts authorize us to conclude that the ancients used gold for the ruby glass, or cobalt for their blue glass, I dare not pronounce. The authors on each side are enumerated by Bergman, and some of the arguments also: but as it is now ascertained from recent experiments by Klaproth, Morveau and le Sage, that glass may be coloured red by an oxide of copper, and as Mr. Wedgewood is known (on his own authority) to have produced most of the colours on his ware by Iron in different states of oxidation, there is no necessity to presume such an amount of chemical knowledge among the ancients, as would be necessary to make a solution and precipitation of gold even without supposing they were acquainted with the sub oxide generally known by the name of the purple powder of Cassius. Blue glass was also made by Mr. Delaval from iron; and the blue stones of a tesselated pavement found near Mont Peligarde, being analyzed by Professor Gmelin, gave no trace of Cobalt by means of Aqua Regia. Nor is this metal or its ores named or described in any ancient author. Further Professor

Bergman states, that in the mineralogical apartment of the Academy at Upsal, there are some glass Tesseræ found at Herculaneum, which are blue, and shining, but appear to be gilt by means of a yellow vitreous coating. The blue colour he says does not exhibit that slightly reddish tinge characteristic of Cobalt, and some small pieces, fused with a blow pipe, either on a coal, or with borax, or per se, gave the opaque red, distinguishing copper. 4 Berg. 112.

The method of detecting artificial gems was in principle the same as it is now, by trying their hardness, *cote deprehenduntur* says Pliny.

Beside these articles of glass ware, the Egyptians exported to Rome after the close of the republic, glass drinking cups of various colours, opake, termed *myrrhœ* and *myrrhina*. Hence the sneer in Martial, against the man who drank better wine himself than he gave to his guests.

Nos bibimus vitro ; tu, myrrhâ Pontice, quare ?
Prodat perspicuus ne duo vina calix. 4 Epig. 86.

Egyptian mummies with glass beads have been dug up at Herculaneum, and some of that discription are still to be found preserved in the British museum and else where. It is probably in this sense that Herodotus and Diodorus Siculus are to be understood when they speak of the Egyptians enveloping their dead in glass, unless indeed some transparent varnish might give rise to a deception: for of the colours perfect and distinct that have been observed painted upon Egyptian mummies now remaining, Bergman enumerates, white, black, blue, red, yellow and green, and these colours of course they might give to their varnishes. Many of the mummies are well gilt.

I do not recollect any thing further respecting the Egyptian Glass manufactories, or those Syria generally, or Phœnicia in particular. The beautiful stained marble, so much admired by Norden among the ruins of upper Egypt, are scarcely to be deemed a part of this branch of our subject.

But while treating on the glass of early times, I think it may be worth while to finish all that I have to communicate respecting the knowledge of the ancients upon this subject.

Of the specimens of ancient glass now remaining, the Sacro Catino or holy Basin of Genoa removed into the Imperial library at Paris, is undoubtedly the largest, being 15 paris inches and 2 lines long, and 6 inches and 4 lines broad, and 4 inches and 8 lines deep. I have already mentioned the reasons that induced Morveau to pronounce it a production of art.

The specimen of flexible glass presented by some artist to Tiberius Nero is mentioned by Dio Cassius, by Petronius, and by Pliny xxxv. 26. but with the latter author, I doubt the fact: Ferunt Tiberio Principe excogitatum Vitri temperamentum, ut flexibile esset: et totam officinam artificis ejus abolitam, ne æris, argenti, auri, metallis pretia detraherentur. Eaque fama crebrior diu quam certior fuit. Indeed this property is inconsistent with all we know of glass. Petronius mentions (and so does Dio Cassius) that the artist broke the vessel in the presence of the emperor, and mended it again upon the spot, and that he was put to death. I regard the whole as an unfounded Tale. Petr. Arb. 189, 190. Dio Cass. L. 57.

There can by no doubt however, of the reality of the antique glass specimens exibiting the same Image on every plane when cut horizontally; and this too of many colours, as in the case of a bird like a dove, described by Winkelman as found at Rome in 1766 and by Klaproth. This was doubtless managed by placing upright fine filaments of coloured glass in such a manner as mosaically to form by their points the coloured figure required; these were probably then connected by means of a flux some what softer than the filaments themselves, and exposed to a fire graduated accordingly. Nor can there be any doubt as to the tesselated pavements described by count Caylus and Winkleman. Indeed the whole history of ancient glass is very curious; but highly as good clear glass was valued in the time of the Emperors, and altho' glass vessels as Pliny says in the passage already quoted, had almost superceded Gold and Silver, yet perfectly clear specimens were so scarce, that Nero gave 50,000 £ sterling for two drinking cups of that description each of which had two handles; and these also are called "modicos calices." xxxvi. Plin. 26.

Burning glasses were known to the ancients. They are described in the Orphic Verses, which tho' not genuine perhaps, are very ancient: they are noticed by Aristophanes; and Pliny mentions the power of water in a transparent glass vessel of burning linen; additâ aquâ, vitreæ pilæ sole adverso in tantum excandescant ut vestes urant. Plin. Ib. The burning glasses of Archimedes were probably concave mirrors of large diameter made either of separate pieces of glass, rock crystal, or polished metal. Plutarch also mentions burning glasses in his life of Numa, and I shall collect other authorities in the notes I propose to add to this lecture.

Proceeding now with the Chemistry of the Egyytians, I shall notice the very curious passage wherein Pliny mentions their Knowledge of what are now called *mordants* in dying; that is, substances which having at the same time a chemical affinity both with the linen or cotton and also with the colouring matter of the dying ingredients, form a triple compound, not easily acted on by air or or by soap. In modern processes for dying on cotton or linen, this mordant is either the triple sulphat of alumine, or the solution of tin in nitro muriatic acid, the acetite of copper, or the acetite of iron. For printing on these substances, the mordant is the acetite of alumine; on woollen, the colours are fixed by the tartrite of alumine mixed with the sulphat, or in scarlets, crimson, and purples, by the nitro muriat of Tin. In Egypt I conjecture, they used nothing but alum and sulphat of Iron, which are plentifully found in the earth. Pingunt et vestes in Egypto, inter pauca mirabili genere; candida vela postquam attrivere, illinentes non coloribus, sed colorem sorbentibus medicamentis: hoc cum fecerunt, non apparet in velis; sed in cortinam pigmenti ferventis mersa, post momentum extrahuntur picta. Mirumque cum sit unus in cortinâ color, ex illo alius atque alius fit in veste accipientis medicamenti qualitate mutatus, nec postea ablui potest. Ita cortina non dubie confusura colores si pictos acciperet, *digerit eos ex vino*, pingitgue dum coquit; et adustœ vestes firmiores sunt quam si non urerentur. 35 Plin. 11. Thus if a piece of cotton printed with strong acetite of alumine, with strong acetite of iron, with weak acetite of alumine, with weak acetite of iron, and with a mixture of equal parts of each (of which the stains need be hardly visible) and then dipt in a boiler containing madder, the cloth will come out dyed with a light red, a deep red, a grey, a black, and a chocolate colour. The latter part of the passage si pictos acciperet, seems to imply that they knew the modern method of printing by discharging partially the colours of coloured grounds: probably the digerit eos ex vino, means the application of strong vinegar. The expressions *pingunt* and *illinentes*, shew that like the modern Hindoos (as I believe the case is) they did not understand the art of block printing, but they pencilled all their colours.

I do not dwell on their dyed colours, (tinctos,) such as red, crimson, purple &c. (Herod. Eut. 132.) for all that the Jews were capable of doing in this way, the Egytians certainly were competent to; but I cannot help thinking that this mode of dying or rather printing by means of mordants, is one proof among others that the Egyptian (22.) knowledge is of Hindoo origin, tho' as the successors to the Shepherd Race were certainly blacks, as Herodotus expressly says they were, I doubt whether they can be referred to the Hindoos, unless an Ethiopic mixture might have changed their complexions. It is not ascertained I think whether the Gypsies are Egyptians or Hindoos. The Egyptians were in the habit of coasting round the Arabian Gulph (M. Ameilhon sur le Commerce des Egyptians) and the seaboard of India, and had regular caravans to Palibothra (Canoge) up the Ganges, and I believe to Benares, a city famous for many ages as the grand repository of East Indian knowledge sacred and profane. The people themselves subsequent to the Shepherd race, seem to partake of Ethiopic and Hindoo origin.

They made *Beer* (23.) Zythum, as well as wine, for Herodotus in Euterpe 60 mentions the wine of the vine, to distinguished it from the οινος κριθινος or barley wine. Ib. 77. The invention of Beer was attributed to Osiris. Diod. Sic. L. 1. c. 20, 34. 13 Plin. 5. 2 Discor. c. 109, 110.

Their *Vinegar* also was particularly admired; 9 Plin. 35 and indeed it must have been strong, to dissolve the pearl of Cleopatra.

Their *pharmacopeial* preparations, consisting of expressed oils, infusions, decoctions and mixtures, are mentioned, by Dioscorides, Pliny and Galen, who notices among them turpentines, red oxyd of copper, verdigrease, sal ammoniac, and burnt alum. The ingredients of their plaisters or ointments I cannot always ascertain; thus lithargyrum and spuma argenti are substances of which, I cannot well make out the difference, unless tin entered into the composition of the latter: nor do I know what modern names to give to the Diphryges, the Misy or the Sory. (26 Plin. 11. Galen de ant. L. 2. c. 11. Dioscorid, L. 1. c. 24. Galen comp. med. L. 5. c. 1.)

Dioscorides also notices their Alabaster boxes for ointments and perfumes, and both he and Strabo mention what may be called their mortars of Granite. Strabo Geog. L. 17. 36 Plin. 8. Granite, or Sienite, I think, is the Pyrropoecillum of the ancients.

Oil (24.) for burning they procured from the olive, and from a plant which Herodotus calls Kiki. They got it also according to Pliny from olives, Rape seed, and Sesamum.

Pitch and Tar (25.) they procured from the combustion of Pine. But I do not think they had any preparation similar to our rosin and burgundy pitch, for distillation was not known, nor can I be brought to think it was described by Dioscorides. The ambix, does not imply it, for the beak is not described: distillation must be referred to the Arabian chemists.

Linen (26.) was one of the staples of Egypt, and they appear to have excelled every other nation in this manufacture; celeberrimum lini commercium says Pliny: but as the fabrication of linen cloth, is no part of manufacture dependant on Chemistry, unless so far as the art of bleaching it, is concerned, I shall pass it over slightly. There is some reason to believe that their fine linen was coarse compared to ours, from a paper of Dr. Halley's in the Philosophic translations of 1764. Cotton (Byssus) appears to have been the dress of the Priests, and was a common article in Ethiopia. I suspect they learned the use of it from Indostan. The bleaching whether of cotton or linen, in that warm climate was attended with no difficulty. Their soda, sun, and air, with frequent washing, would there, as here, nearly supercede the elaborate process necessary in the climate of Great Britain or Ireland: nor can we suppose the same lustrous whiteness, or the same gloss in the finishing, required at that time, as by the luxurious eye of modern refinement.

Diodorus Siculus, who visited Egypt and appears attentively to have observed the general state of Egyptian art and manufacture in the time of Agustus Cæsar, mentions among other things, their skill in the artificial hatching of domestic fowl; a subject, which in modern days has given birth to an elaborate essay of Reaumur (L'Art de faire eclore les oiseaux domestiques;) a book which would have been more useful, had he omitted a disquisition by no means calculated to introduce his volume into the domestic library.

Naucrate, the Greek colony at Egypt, became famous for its poultry. The stained marble noticed by Norden in upper Egypt, and Pococke among the ruins of Thebes, evince great skill in this department of chemical art.

Common Salt [27.] they extracted from the lakes in the neighbourhood of Memphis: and no doubt from the salt Mountains of the country described by Dr. Shaw in his travels about the middle of the last century, and again by Horneman in 1802. Such mountains are noticed by Pliny in other places, (31 Plin. 7.) and the salt mountain in Spain described by Bowles, by Gmelin and by the Rev. Mr. Townsend is well known. Excepting the indirect probabilities suggested by Capt. Pike, we have no sufficient authority for the salt mountain said to exist near the Arkansas, tho' such a rock was long ago laid down in the French maps of Louisiana, particularly in a map in my possession by M. De la Rochette. The *natron* (28.) of the ancients was not nitre: but the fossile alkali, or alkali of Soda; probably procured from the incineration of marine plants growing about the lower lakes, and on the seabord of the Delta. It might indeed be contaminated with cubic nitre, in such a climate, owing to the nitrogen arising from animal putridity.

Natron was likewise found at the Greek settlement of Naucrate and also at Memphis. The passage in Pliny which is my authority, has expressions that may be referred according to Bergman to the sublimation of salmmoniac, which is also mentioned by Athenæus, (Deipnosophist. L. 2. c. 29.) as an article of export from Egypt into Persia. Natron however was used for salting meat, Herod. Eut. 77. 11 numb. 32.

Their alum is mentioned by Pliny, as a mordant for dyed goods, that is, using modern language for his meaning.

Diodorus Siculus (L 3.) mentions the great number of persons imployed in searching for gold; these were fastened together by the legs. He notices also the great excellence of their workmen in brass and gold, and the complicated but scientific method [29.] of procuring the pure metal from the mineral. Their silver utensils were ornamented with serpents of gold; and these were either varnished or enamelled (I know not which) black, blue, and yellow; by what means I have not been able to make out from the expressions of Athenœus as cited by Bergman. [30.]

The Egyptians continued to excel in all the arts and manufactures relating to chemistry, without rivals in Europe at least, until the overthrow of Alexandria by the Arabians. After the death of Alexander the Great, Egypt fell to Ptolemy Soter, and was governed by a succession of Ptolemies for about three hundred years, with infinite benefit to their agriculture, their manufactures and their commerce. The library began by Ptolemy Soter consisted of Books of prepared Papyrus; for parchment, (Pergamena charta) brought to perfection by Eumenes King of Pergamus, was introduced to rival the Egyptian monopoly of papyrus. This library was gradually encreased to a million of volumes, till it was burnt down by accident by the army of Julius Cæsar on his descent against Cleopatra. Seven hundred thousand volumes more were collected; but when in the fourth century Diocletian overran revolted Egypt, he ordered only the Alchemical books to be burnt; for as yet we have no account of any treatise whatever on the practice or principles of chemistry, till the credulous and the knavish among the Egyptians, professed the art of making gold. Diocletian appears really to have given credit to these pretentions, and his motive for this destruction, was lest the Egyptians should acquire such enormous wealth in time, as to enable them to withstand the Roman power. But there were three or four causes, fully sufficient to account for the wealth found in Egypt without recurring to Alchemy to explain it, 1st the great fertility of Egypt, particularly of lower Egypt, and the consequent condensation of population among them, rendering all articles of produce cheap, from the cheapness of labour, and giving rise in consequence to great demand. 2dly. Their monopoly of the linen trade, the paper trade, and almost of the whole glass trade of the world, by means of their home manufactured staple articles. 3dly. The anxious encouragement given to Commerce and naval affairs particularly by the Ptolemies; extending even to the centre of Hindostan. Palibothra where they regularly traded, also seems to have been for some thousand years the centre of knowledge of that country. 4thly. Their internal trade to the heads of the Nile; embracing no doubt the present sites of Tombuctoo and Houssa, the most auriferous quarter of the globe even at this moment: and where the more than European skill in manufacturing gold trinkets, or in the scripture expression, jewels of silver and jewels of gold, is testified by almost the only traveller of value and authority to the Barbary States, Mr. Jackson. This skill may probably be conjectured as a remnant of Egyptian art.

Skilful as the Egyptians were in chemical art and manufactures, and numerous as their fraudulent books on alchemy probably were, I know of no remains of chemical knowledge recorded by them, either in books or inscriptions; for the fragments of Hermes Trismegestus are hardly to be deemed authentic, and are utterly devoid of sense and value if they were.

After the destruction of the Alexandrian library in Cæsar's time, and the Invasion of Diocletian, about 700,000 Volumes more were collected as I have already noticed. These, according to Abulfarez were burnt with unrelenting vengeance by the Mussulmen under the Caliph Omar: who argued with the ferocious logic of a true believer, that if they contained any thing derogatory to the Scriptures of his faith, they were dangerous, and if they did not, they were useless. For 6 months they supplied the fuel to 4000 public baths. Hence also it may be inferred that these books must have been manufactured not of parchment or the Pergamena Charta, but of [31.] Papyrus. Indeed, the Egyptians would of course give currency to their own staple upon such an occasion, and use it exclusively for the purposes of literature. neither would parchment serve as fuel.

I do not know of any thing in my estimation worthy of notice to be added to this brief sketch of Egyptian art. I shall therefore proceed to the Greeks and Romans, and mention what appears to me worthy of remark in the history of Chemical knowledge among those people. The subject of glass, I have already exhausted so far as the bounds of a lecture will permit me to descant on it, but it deserves a separate and much more extended consideration.

Among the Greek and Roman Classics, very few works of science comparatively have come down to us. These people seem always to have paid more respect to works of imagination, than to books containing knowledge. What we have left of Archimedes Euclid, Diophantus, Apollonius Pergæus, Aristarchus, Theodosius, Proclus, and Cleomedes, are mathematical. Strabo and Ptolemy have thrown much light on the geography and astronomy of the ancients. Aristotle whose wonderful extent of knowledge embraced almost every subject (32.) mentions at the end of his third book on meteorology, that he is about to treat on Fossils; but this part of his works has never reached us. Theophrastus the Eresian his successor, has treated of plants and stones: the two small books, of Aristotle on plants are spurious. The work of Theophrastus on stones was translated by Sir John Hill, with as much knowledge of the subject as the times afforded. Strato of Lamsacus came after Theophrastus, but his treatise de machinis metallicis has not reached us: neither has the work of Democritus on stones cited by Columella 33. or the Verses on metals of Philo: as to the supposed treatise of Orpheus on stones, it suffices barely to mention it. From him to Dioscorides, and Pliny, I do not recollect any ancient writer whose works have been handed down to modern times on scientific subjects. Pliny's natural history is a prodigious and invaluable register of scientific facts; it is a book that richly deserves a much better translator and a more enlightened annotator than it hath yet received. Indeed, it is almost too much for one man to undertake. Mr. Kidd in his mineralogy has shewn much learned ingenuity in his conjectures as to the ancient minerals decribed or mentioned by this author, Theophrastus and Dioscorides. With Galen and Oribasius, this list must close; for the copyist Solinus, is hardly worth notice; and the annotations of his Commentator Saumaise (Salmasius) have not added very greatly to the value of the book.

Let us take then a brief review of the state of chemical knowledge among the Greeks and Romans.

Servius the commentator on Virgil mentions that the Trojans had the figure of Neptune painted on their Shields, and the Greeks that of Minerva; but we can collect little from this vague notice of the fact. The shield of Achilles (33.) was certainly intended by Homer to give his reader an idea of a chief d'œuvre of art for the time he composed: and it appears that the mode of manufacturing polished Iron and engraving on it was then well known. Hence we need not be surprized at the polished Iron bowl beautifully inlaid, which Herodotus afterward admired at Delphi. (Euterpe.)

As to the offensive weapons of that day, and indeed long after the Trojan war, they appear to have been composed not of Iron and steel, (the latter combination of carbon and iron, being found out long after,) but of copper alloyed with a tenth or a twelfth part of Tin, to give it hardness. The passage in Homer so often noticed as an instance of the correspondence of the sound to the sense, (well in the translation, better in the original) can be explained on this supposition.

The brittle steel unfaithful to his hand,
Snapt short.

(Combat between Menalaus and Paris. 3. Ib. 363. The original is not Steel : Xiphos arguroelon, a silver studded Sword. Pope has no pretensions to accuracy.

Many ancient weapons also have been analysed, of which, these two metals seem to form the component parts. I say nothing about the ancient story of the Phœnix, or the expedition of Jason and the Argonauts after the golden fleece, or of Hercules killing the Hydra, all which the Alchemists have arrogated as symbolical of their mysteries, for as I have no credence in the chrusopoietic art, which was certainly not in vogue at an æra so early, I do not consider these tales as in any degree allusive.

Nor am I persuaded that the Nepenthes (34.) of Homer, was the opium of the moderns, though I acknowledge I do not know of any drug whose effects are so similar. The hop, the hemp, the stramonium, the betel, the white hellebore, and some other vegetables might perhaps furnish an extract of strong narcotic qualities, but we have not sufficient facts handed down to throw light on our researches on this head. I am in doubt also respecting the knowledge of the ancients on the subject of sugar, (35.) though it certainly seems to be noticed by Theophrastus, Pliny, and Dioscorides. Neither shall I say any thing concerning the knowledge of Democritus of Abdera; for whatever knowledge he might individually have possessed, neither Diogenes Laertius or Syncellus give us any useful information concerning it; nor can any part of it be traced either in any work that hath reached us, or in the common practice of his cotemporaries or followers; He wrote enigmatically concerning gold and silver and precious stones and purple. He seems also to have learnt in Egypt the manufacture of artificial gems. Neither do I agree to the ingenious reverie of Dutens (V. 2. p. 81.) that the ancients possessed the knowledge of gunpowder and that the story of Salmonius alluded to this knowledge.

The Greeks worked a gold mine at Thasum one of the Egeian Isles, and a silver mine at Laucium. The Orichalum of Corinth was of three kinds, the one imitating silver, the other gold, the third of an intermediate colour ; probably brass, which according to Pliny was made as it now is from copper and lapis calaminaris, 50. Pl. 34. 5. Dioscorid. 85. Steel was made as at present by fusing iron with charcoal as is noted both by Arist. Met. IV. c. 6. and 50 Pl. 34. Copper was furnished by the isle of Cyprus. Cerussa from Rhodes 50. Pl. 34. but I cannot say that the Cerussa of the ancients was our white lead. Cinnabar (Minium) was discovered by Callia an Athenian about 500 years A. C. according to Theophrastus Eresius, and Aristot. Met. IV. 8. de Anima L. 1. The Athenians engraved not merely on metals, on pearls, corals, and marbles, but basalt and porphyry, on agates, carnelians, and onyxes ; on the latter in alt relief. 34. Pl. 9. which certainly implies great chemical skill in the fabrication of the tools. [36.]

Rhæcus and Theodorus about five hundred and fifty years before the Christian æra, excelled as Founders, 36. Pl. 5. Indeed Praxiteles, was accustomed to cast in metal 34. Plin. 8. The colossus of Rhodes near

120 feet high was the work of Chares, it cost twelve years labour and 300 talents. It was erected about 274 years A. C. it stood 56 years, when an earthquake threw it down. 34 Pl. 7. It lay on the same spot for near 900 years, when the Saracens in 672 sold it to a Jew, who loaded 900 Camels with the metal. (Gibbon.)

Leather dressing, was discovered by Tychius of Beotia. Plin.

Plato in his Symposium describes filtration (37.) thro' flannel. Hippocrates in his treatise on Hemorrhoids, Calcination. Galen (de sanitate tuenda L. 4. c. 8) the water bath and the oil bath. Both Galen and Dioscorides seem to have known sublimation. Galen de medic simp. fac. L. 9. Dioscor. mat. med. L. 5. c. 110. but certainly not distillation. The Ambix or cover of a boiler mentioned by Dioscorides, was converted into an Alambic by the Arabian Chemists afterwards adding the beak.

The Greek fire, seems rather an invention of the second æra of Chemistry. (38.)

I have few others facts to add to this account of the State of arts in Greece. (39.) What the ROMANS knew of the arts, they learned partly from the Greeks and partly from the Egyptians; and from the former particularly, the beauty of outline and design in all their ornamental paintings, in their vases, their drinking vessels, their candelabra, their triclinia, and even their kitchen utensils, as the ruins at Herculaneum and Pompeii sufficiently evince (40.) The richness and even gaudiness of colouring in the compartments of their dwellings, show that chemical knowledge amply supplied them with colours of great beauty and brightness, and durable beyond the most of ours. (41.)

Indeed, the arts and literature of Greece from the time of Memmius to the time of Juvenal and long afterward, were extremely fashionable at Rome. In the days of Lucullus and Cicero (as we gather from Plutarch) every gentleman pretending to good education, was expected to understand the Greek language. "Haud cuivis attigit adire Corinthum," was a common saying, which may fairly be translated in modern language, "it is not every man who has the opportunity of making the grand Tour," and sufficiently shows in what part of the world the Romans apprehended taste was to be gratified and knowledge acquired. Juvenal was outrageous upon the subject; "non possum ferre Quirites, Græcam urbem." "Græculus esuriens ad cœlum jusseris ibit."

The processes for dying the finer colours, for colour making, for preparing medicines, for guilding with mercury (Pl. L. 33. c. b. c. 8.) and for recovering by amalgamation with mercury, the gold of worn-out embroidery (7 Vitr. 8.) may be considered as Roman processes borrowed from Greece and Egypt. Soap is men-by Galen, Oribasius, Paulus Egineta, and Etius, who according to Bergman (4 Berg. 79.) describes the preparation of zinc (cadmia) and antimony (stibium) but I have no opportunity of turning to the passages. Zinc or calamine has been supposed to be a discovery of Cadmus: but this is Etymology.

The Greeks however were indisputably indebted to the Egyptians and Phœnicians for all they knew; and as it seems to me, so were the Egyptians and Phœnicians in many respects to the nations eastward. Much knowledge of various kinds may fairly be attributed to the Pishdadian Dynasty of Iran or Persia, prior to the Assyrian Monarchy; from whence Sir W. Jones (who never appears in his asiatic disquisitions, to have strayed beyond the pale of orthodoxy) dates the commencement of Hindoo Mythology.

I have stated before, that without introducing any theological opinion to confute or confirm the mosaic history, I think that the chronology of arts and civilization therein given, accords so well in its general features with collateral facts and testimonies of the best authority, that adopting the chronology of the seventy, and judging of the mosaic history, as I would of any other, I think it fairly entitled to great consideration, and indeed to preference. Rejecting therefore all the fables of Chinese and Hindoo chronology, I regard those accounts only as worthy of attention which approach something near to the Mosaic relation. According to the most intelligent of the Bramins, the Vedas were composed about 260 years after the deluge. Sir W. Jones and Dr. Priestly adopt the date of 1580 years before the Christian æra as the date of the Vedas, which make them about a hundred years anterior to Moses. M. Bailly and professor Playfair however, seem to have made it probable that Indian astronomy had its origin 3102 Years before Christ. I leave to better astronomers than myself to reply to M. La Place, and Mr. Bentley on this point whose objections are certainly worth refutation if they can be refuted.

I do not mean by this, to compare in any degree the Institutes of Menu, the Ezour Vedam, the Puranas, the Shastas, or any other work of Hindoo literature however ancient, in point of importance with the Christian Scriptures. As the earliest history of mankind, of the migration of families, of political events, of the progress of civilization, arts, manufactures, and commerce, of the manners and customs, rites and ceremonies, theological doctrines, and ethical precepts, not only of the Jews, but of nations surrounding and connected with them, the Bible is indeed a Book, exceedingly curious, interesting, and instructive: and independent of points of religious controversy wherewith chemistry has no right to intermeddle, it well deserves to be carefully perused. Compared with this book, the silly tales of Hindoo mythology are beyond measure trifling and insignificant. But a people, whose astronomical calculations certainly mount higher than those of any other, and among whom books were published *at least* as ancient as the time of Moses, may lay claim also to no slight progress in arts and manufacturies, even at that early period. Nor can it be deemed improbable that their knowledge gradually became the foundation of all that was known among nations of a posterior date, who could have had any intercourse with their predecessors of the East.

It is at any rate sufficiently clear, that the Chaldœans, the Persians, and the Hindoos were a civilized people, cultivating the arts some time prior to the Egyptians; who if they borrowed from one or other of them (as they did) the names and figures and divisions of the Zodiacal signs, if they had the same planetary denomination of the days of the week—and the same number of weeks—the coincidence is too strong not to furnish reasonable grounds for believing, that the later civilized country borrowed also the arts of their earlier and more civizlied neighbours. The history of ancient art therefore would be incomplete, without touching on the arts and manufactures of the eastern world.

In fact there have been chemical processes known among the Hindoos and Chinese from time immemorial that European science cannot yet either explain or equal. The account given by Pliny of Egyptian printing, no one conversant with Callicoe printing will doubt of being derived from the artists of Indostan; whose colours are more vivid, and (as I guess) whose processes are more simple, than any yet discovered by the Europeans. Their colouring drugs are not the same, nor are their mordants so complicated. Their red dye is from a gallium; for galls they use myrobalans; the mordant seems to me to be pencilled, and in some cases I have suspected chemical colours on their chintzes, that is, colours not raised by immersing the whole cloth in a boiling infusion of the colouring drug, but laid on in the first instance upon the precise spot where they were intended to appear. A second or light red of this kind, I have long known, tho' its application requires much caution, but a full and deep red of the same description, that would superscede the necessity of dying the whole piece in the madder bath, would be a discovery invaluable to the European artist. The cuttings and polishing of precious stones, and the working in various metals, were certainly practised by the Hindoos long before any European knowledge of the kind appears. The Athenian ambassadors describe the glass drinking cups ualina ekpomata, in use among the Persians before the time of Alexander the Great. (Aristoph. Acharn. I. 2.) (42.)

As to the CHINESE alchemists 2500 years before the Ætian æra, let those who believe in alchemy give credit to the chronolgy of the faet. The Jesuit missionaries Marten, and Le Compte, ought to have been less credulous. I do not however think the conjecture of De-Guignes so improbable, that the Chinese might have been an Egyptian colony; (43.) but the ancient Egyptian feature and complexion, are (44.) more traceable to

Ethiopia at one period, and to Hindostan at another, than to China. I agree however with Bergman, that no reasonable man can doubt of the great antiquity among the Chinese of the knowledge of nitre, borax, alum, verdigris sublimate, calomel, mercurial æthiops, sulphur, gunpowder, fire works, and the manufacture of porcelain. They well knew also how to paint with enamel colours of great brilliancy. Gold, silver, copper, mercury, lead, tin, zinc, and cobalt, must have been known to them. Their white copper, or tutenag, Bergman says is a mixture of copper, nickel, iron and zinc. I suspect it to be chiefly nickel. The English tutenag, is copper, tin and arsenic. Doubtless even at this day, the porcelain of the Chinese is more perfect, their art of colour making more skilful, their composition of fire works more scientific and brilliant, than any thing that Europe can pretend to. But we have no means of fixing dates to the origin of any part of this knowledge.

I proceed therefore to the state of the arts dependent, on chemistry, and to the state of chemistry as a science during what are called the DARK AGES, from the middle of the seventh to the middle of the 17th century; relying much on Bergman's Historiæ Chemiæ Medium Ævum. This period will reach from the taking of Alexandria by the Saracens, in 642, to the establishment of the philosophical academies in Europe. That of Del Cimento in Florence in 1651: the Royal Society of England in 1660, and the Academy of sciences at Paris in 1666.

From the commencement of this period until the Arabian physicians, Geber, Rhasis, Avicenna, and Albucasis, I can find nothing done; but to these men it is owing that pharmaceutical chemistry put on the appearance of an art founded on principles: and very many of the processes and preparations now in use, were practised and described by them in plain and unaffected language. These writers flourished from the beginning of the 9th to the beginning of the 12th century; and they detail among other things, the uses of alembics and cucurbits; the distillation of wine and vinegar, the preparation of sal ammoniac, of crocus martis, of the vegetable and mineral alkalies, the sublimed acetite of mercury, and as it should seem, even of corrosive sublimate, or the oxygenated muriat of mercury as it is now found to be. The method of preparing mercurius dulcis or calomel, was first published by Crollius in 1690; and the use of sugar, or the honey of the cane. 4 Berg. 96 not. and 99.

The 12th century produced Albertus Magnus and Roger Bacon. I know little that the works of the former author have added to chemical knowledge, great as his reputation is, nor indeed much that the latter has contributed. That he was acquainted with the principles of optics, and the properties of concave and convex lenses—that he first suggested the propriety of reforming the Julian calendar and the principles on which it should be done—that he understood and described (though anagrammatically) the nature and composition of gunpowder, (45.) is not to be denied; and his Opus Majus, edited a few years ago by Dr. Jebb, implies as Dr. Friend truly remarks, a knowledge of many of the chemical processes in use at the beginning of the 18th century; but I cannot point out the facts by which he so plainly encreased the mass of chemical knowledge as to enable others to pursue his own ideas, or reach his own attainments.

Distillation was now one of the great resources of chemistry particularly pharmaceutical chemistry. John Mesues of Damascus in the 12th century, notices the distillation of rose water, oil of amber, oil of barley, and the modern quack medicine oil of bricks, as preparations long known; and in the 13th century (1270) Thaddeus of Florence praises the virtues of spirit of wine.

The alchemical notions of the philosopher's stone and the universal medicine, began now to obtain more than usual credit. The Arabian physicians and chemists, particularly Geber, appeared to have imbibed this mania from the chrusopoiests of Egypt. The notions of Geber, of a common metalline basis called mercury, and a metallizing and inflammable principle called sulphur, was adopted also by Roger Bacon. and pervades so far as I have observed and can understand, all the alchemical writings. I say can understand; for many years ago I spent much time and assiduity in striving to acquire some knowledge from the great collection of alchemical writers in the Bibliotheca Chemica of Manget, but in vain. Nor have I been enabled to derive any useful information from my researches into the history and writings of the fraternity of Rosicrucians, of whom the Free Masons appear to me the humble imitators. To Basil Valentine, however, in the beginning of the 15th century the public is indebted for the medicinal reputation of antimony, and to Theophrastus Paracelsus in the 16th medicine owes the introduction of the most useful because the most active preparations; namely, those of which metals form the basis, particularly mercury. It is to the boldness of his theory, and the success of his practice, that we are indebted for the pharmaceutical opinion which every day's practice more and more confirms, that the worst of poisons, are the best of remedies, from the vegetable as well as from the mineral kingdom. Cotemporary with Paracelsus were Glauber and George Agricola; to the former we owe some preparations before unknown, particularly the sulphat of soda, and some very well contrived chemical apparatus, from which Wolf borrowed the idea of his improvements. The treatise De re Metallicâ of George Agricola, as it is the first scientific chemical work is also a truly scientific performance, and well calculated to condense and encrease the mining and mineralogical knowledge of his time. Glass windows were known at the end of the third century. Gregory of Tours mentions coloured glass. The glazed cupola of St. Sophia at Constantinople dedicated by Justinian to our Saviour was much extolled. Glass works were known in France in the 7th century. Then in England. Afterwards in Germany: still later among the more northern nations. Raymond Lully, and Isaac Holland were supposed to have contributed much to the fabrication of coloured glass, which was greatly improved by John Van Eick or Van Brugger, who has also the credit of having invented painting in oil. The processes of the day are faithfully given by Neri in his Ars Vitriaria, of which Dr. Merret published an English translation in quarto with Kunkel's notes. Even as yet however, this beautiful part of chemistry is not in perfection, nor does any publication give the real method of colouring porcelain used by the English, which is said to be very different from the processes detailed by Brogniart. The red from copper and the green from chrome are recent discoveries. The latter appears to me of little value. The art of dying during this period became very much improved, particularly by the introduction of archil by a Florentine manufacturer in 1300. The discovery of America furnished new materials, such as logwood, brazil wood, indigo, and cochineal, which superceded gradually the ancient kermes berry; but the modern doctrine of mordants was still unknown, in Europe at least; and I can find no traces of the art of printing on cotton or linen, out of Hindostan. The famous Gobelin is said first to have succeeded in dyeing scarlet in the reign of Francis the first; but Drebbel the inventor of the thermometer was certainly before him, and his son-in law Cuffler practised as a scarlet dyer. Toward the middle of the 17th century a new æra began to unfold itself: scholastic metaphysics, (46) and the reveries of alchemy began to lose ground, and a method of reasoning less technical but more intelligible took place of the one, and science founded upon facts carefully repeated and accurately registered, succeeded to the other. Not that the labours either of the alchemists or the schoolmen were useless; the former discovered many facts and processes, in the course of their pursuit, and they kept alive an ardour for their science, ultimately productive of the most beneficial effects. I fear they cannot be acquitted of a degree of vain boasting respecting their art, which more than approaches to deliberate falsehood; and yet there is evidence of gold having been made, so difficult to be refuted, that readers not aware how easily men impose upon themselves as well as others, would be strongly tempted to give credit to the fact. The account given of George Ripley, and the relations collected by Bergman (His. Chem. Med. æv. Sect. 2.) are enough to stagger moderate incredulity. Nor are the facts explained, which caused the unfortunate death of Dr. James Price of Guildford in 1782, an account of which may be found I believe in the periodical publications of that year. That he *appeared* to have made gold is certain, that there was some deception was almost equally so, considering that he preferred suicide to explanation. I knew him—a gentleman in his outward deportment—rich, liberal, full of all kind of knowledge, chemical especially. His chemical lectures were delivered gratis to his neighbours at Guilford. Upon the whole, the present state of our knowledge, makes it highly probable, that gold never has been made artificially; and that it cannot be. But we are not warranted in either case, to speak with certainty. A true philosopher says Rousseau, has frequent occasion to say *j'ignore;* seldom indeed to say *c'est impossible.*

Notwithstanding the triumphal chariot of antimony of Basil Valentine, the faculty at Paris forbad the use of this preparation in 1566: in 1590 they set the first example of publishing a regular Pharmacopœia, by means of which, physicians might always be sure of the sameness of their prescriptions. There is a curious passage in Rabelais concerning chemical tests.

"A letter which a messenger brought to Pantagruel "from a lady of Paris; together with the exposition of a "Posey written in a gold ring.

"When Pantagruel had read the superscription, he was "much amazed, and therefore demanded of the said mes-"senger the name of her that had sent it. Then opened "he the letter, and found nothing written in it nor other-"wise enclosed, but only a gold ring, with a square table "diamond. Wondering at this, he called Panurge to him,

" and shewed him the case; whereupon Panurge told him, "that the leaf of paper was written upon, but with such "cunning and artifice that no man could see the writing at "first sight. Therefore, to find it out, he set it by the "fire, to see if it was made with sal ammoniac, soaked in "water. Then put he it into the water, to see if the letter "were written with the juice of tithy malle. After that, "he held it up against the candle, to see if it was written "with the juice of white onions.

"Then he rubbed one part of it in oil of nuts, to see if "it were not written with the lye of a fig-tree; and another "part of it with the milk of a woman giving suck to her "eldest daughter, to see if it was written with the blood "of red toads, or green earth frogs. Afterwards he rub-"bed one corner with the ashes of a swallow's nest, to see "if it were not written with the dew that is found within "the herb alcakengy, called the winter cherry. He rub-"bed after that, one end with ear-wax, to see if it were "not written with the gall of a raven. Then did he dip it "into vinegar, to try if it was not written with the juice of "a garden spurge. After that he greased it with the fat "of a bat or flitter-mouse, to see if it were not written with "the sperm of a whale, which some call ambergris. Then "put it very fairly into a bason full of fresh water, and

" forthwith took it out, to see whether it were not written " with stone alum. But after all experiments, when he " perceived that he could find nothing, he called the mes- " senger, and asked him, Good fellow, the lady that sent " thee hither, did she not give thee a staff to bring with " thee? thinking that it had been according to the con- " ceit whereof Aulus Gellius maketh mention: and the " messenger answered him, no sir. Then Paurge would " have caused his head to be shaven, to see whether the " lady had written upon his bald pate, with the hard lye " whereof soap is made, that which she meant; but per- " ceiving that his hair was very long, he forbore, consi- " dering that it could not have grown to so great a " length in so short time.

" Then he said to Pantagruel, Master, by the virtue " of G— I cannot tell what to do nor say on it. For to " know whether there be any thing written upon this or " no, I have made use of a good part of that which " master Francisco di Nianto, the Tuscan, sets down, " who hath written the manner of reading letters that do " not appear: that which Zoroastes published, peri " grammaton acriton: and Calphurnius Bassus, de lit- " teris illegibilibus. But I can see nothing, nor do I " believe there is any thing else in it than the ring. Let " us therefore look upon it."—

I have searched Ben Johnson's Alchemist in vain for some trace of the learning of the day. Nor is there any thing worth notice in the Alcumista of Erasmus, either as to the processes used, on the methods of deceiving. These was by false linings to crucibles, by charcoal and fluxes previously managed, and mixed with a preparation of gold, and by hollow spatulas.

The air separated from bodies by fire, by fermentation and by effervescence, had been observed previous to the time of Paracelsus, and noticed under the name of gas sylvestris. He supposed it to be the same with the air of the atmosphere. His disciple Van Helmont first gave to it the name of gas, a spirit or incoercible vapour. (Complexionum atq mixtionum elementalium figmentum No. 13, 14, et seq.) He supposed that of this gas 62lb. of charcoal contained 61, and only one part of earth: that the flatulence of indigestion and the tumefaction of drowned bodies, arose from the extrication of this gas (de flatibus 36.) He determines that it is a different thing from the air we breathe. De Lithiasi cap. No 7. Tumulus pestis.

The production and investigation of artificial air, were prosecuted by Boyle and Dr. Hales by means of the air pump, by fermentation, and by means of chemical effervescence. But they did little more than ascertain that artificial air could be procured from certain substances, and Hales in particular noted the proportions. They did not investigate the kind of air so produced, its habits, affinities and properties. Cotemporary with Boyle, was one of those extraordinary men, who fall into temporary obscurity, in consequence of abilities and foresight, beyond the common capacity of the day. Mayow, was the cotemporary of Boyle and Lower, and Hooke and Ray, and Durham and Hales; yet none of them seem to have comprehended or noticed his five treatises published in 1674, wherein he shews that the atmosphere is composed of two kinds of air. That the one will, and the other will not sustain life and combustion. That of these airs, nitre contains one. He shewed also the method of transferring air under water from one jar to another; and certainly forestalled in a great degree the brilliant discovery that Priestly and Scheele afterward made of Oxygen, and that Lavoisier pretended to have made himself. Mayow's writings were made known by Scherer in Germany in 1792, and by Dr. Beddoes and others in England; about the same time, if I mistake not, for I speak from memory. Boyle and Hooke and Hales, certainly did much at this period, to extend the bounds of natural and chemical philosophy; chiefly the former. Some of Boyle's chemical facts however, are very extraordinary; and as I remember struck me a long time ago with a strong desire to verify such as had not yet received the sanction of repetition: but the dedication of five and twenty years to the practice of the law, either as a counsel or a judge, has confined me in my leisure hours to keep up as well as I was able with the almost daily increase of chemical knowledge during this interesting period.

The societies for the extension of science of all kinds, greatly contributed about this time to diffuse a taste for accurate experiment; and afforded a convenient register for fugitive dissertations and insulated facts.

Lord Bacon was the first among the moderns who pointed out the way by which real knowledge was to be obtained, and turned the minds of the learned, from playing tricks with syllogisms, and the legerdemain of words without ideas, and taught them to rest theory upon the basis of experiment alone. This was necessary: for the logic and metaphysics of Aristotle were misused from being misunderstood; while his physics, his ethics and his politics, full of sound observation and important facts, were neglected. The course thus pointed out by lord Verulam, has since been pursued with a success equal to the most sanguine wishes of those, who rejoice in the continued prospect of human improvement.

Chemistry began now to assume its proper rank, not among the arts of life merely, but among the curious and useful sciences; and as contributing in no slight degree to give profound and accurate views of the most recondite processes of nature.

John Joachim Becher systematized the knowledge of the day, about the middle of the 16th century by his Institutiones Chemicæ, his Theoria Chemiæ Dogmaticæ, and other works, wherein the vast extent of chemistry as a science, and the almost universality of its application were brought to view. In his physica subterranea, he boasts of having been the first to introduce in England the practice of smelting (47) with pit coal; but in Pryce's mineralogy of Cornwall, there are notices of its having been used for this purpose earlier. Becher first among the modern chemists, (for Geber can hardly be so ranked) laid down the theory of a general principle of inflammability, which Dr. Stahl of Vienna his friend and successor adopted under the name of PHLOGISTON: a theory which has called forth in its attack and defence, some of the first rate talents that modern times can boast of : and which indeed, still remains a question, not entirely free from obscurity. Dr. Stahl illustrated his theory by some very ingenious experiments on sulphur. He burnt this substance as long as any thing combustible remained in it, and he found the result was the acid of sulphur. Hence he concluded that the acid of sulphur was sulphur deprived of its principle of inflammability. He treated sulphuric acid, with substances such as charcoal, (lamp black) which were supposed to abound with the principle of inflammability, and he reproduced sulphur. He exposed a solution of liver of sulphur (sulphuret of potash) to a gentle heat, and produced sulphat of potash. Hence he drew the conclusion that in all cases of combustion and calcination, the process consisted in driving off or separating the inflammable part; and that in all cases of revivification, reduction, or metallization, the inflammable principal was restored; and this principle was also in all cases, one and the same substance, if substance it could be called; and was contained in every body capable of combustion : to this principle he gave the name of PHLOGISTON. It was for many years a prominent objection to this theory, that the principle of inflammability was rather an *ens rationis*, than a substance—that it could not be exhibited in a visible, tangible form; separate from the bodies with which it was supposed to be combined. This objection was never obviated till Mr. Kirwan pronounced inflammable air, or the gas now called hydrogen, to be phlogiston; on the supposition that it was produced from the metal itself, during solution or calcination: a theory, which modern chemistry finds reason to reject.

Dr. Stahl however, did not observe, that in his experiments with sulphur, the acid produced, weighed more than the sulphur employed, notwithstanding the loss of the principle of inflammability. To account for this, the Stahlians his successors were compelled to have recourse to a principle of absolute levity, which they attributed to their phlogiston; but this did not agree with the properties of inflammable gas, which certainly had weight, tho' far less indeed, than atmospheric air. I think I may venture the opinion, that levity is not ascribable to any substance but caloric: if indeed caloric be a substance; which I incline to think it is, though Mr. Davy seems to doubt it. Heat clearly opposes all the other attractions, and I see not that the attraction of gravitation is privileged from its operation.

This theory of Stahl's, was firmly seated on the throne of the chemical world, until the triumphant experiments of M. Lavoisier, which I shall have occasion to notice, in their due order of time.

Chemistry about this time began to look up: still however, it held a very inferior place in the ranks of science, to astronomical, mathematical and mechanical philosophy, to which the great talents and patient industry of Sir Isaac Newton principally, gave an overwhelming influence. Mathematics began now to be applied to the explanation not only of every chemical fact, but by Baglivi, Kiell, Friend and Meade, to all the facts of animal life and organization, whether in health or in disease. We now know, that neither chemical nor mechanical philosophy, will fully account for any phenomenon truly physiological, either within the sphere of animal or vegetable organization—whether dependant on sane, or on morbid action.

Chemistry at this time was still in its cradle: even Newton knew little about it, comparatively: yet did this great man, whose very suppositions amount to primâ facie evidence of truth, advance a conjecture since verified, the boldest among the speculations of philosophy from its commencement to the present day; namely, that water and the diamond, were both of them inflammable substances, or contained an inflammable substance; a supposition which he deduced from their great powers of refraction: and experiment has fully verified his conjecture.

The doctrine of factitious airs was not yet understood, notwithstanding the lights thrown on it by Mayow. Boerhaave pursued the track of Boyle and Hales, by ascertaining some facts respecting the air of effervescence, with the assistance of the air pump. M. Venel of Montpelier, and Dr. Brownrigg of London, gave much information on the combination of air with, and its extrication from water, by their experiments on Seltzer water: which of these gentlemen has the honour of this addition to science by right of priority, I do not recollect. I say I do not recollect, for I have not here the books to ascertain it; and I must rely on the resources of my own memory in many parts of this lecture.

I do not think it necessary to notice the experiments and theories of Dr. Meyer, Dr. Macbride, M. Jacquin, M. Crans, and M. de Smeth, founded on the theory of fixed air by Dr. Black; who about the year 1752, ascertained that the causticity and peculiar properties of lime, were owing to the separation of air from it by means of fire: that this air could be restored to it; in which case, it again lost its causticity, and resumed the properties of limestone: that this air was fixed in, and combined with, not only limestone, but the common effervescent alkalies and magnesia: that these substances could be deprived of this fixed air by acids, and hence the phenomenon of effervescence; that it might be again restored to them, and that they then assumed their pristine state.

These experiments of Dr. Black were afterward repeated, confirmed, and extended, by Mr. Cavendish and Dr. Priestley about 1767: the latter I believe first shewed in what way artificial seltzer water might be easily and cheaply made: and Mr. Lane, shewing that water impregnated with fixed air, would dissolve metals, led the way to the artificial preparation of every kind of mineral water. About this period also, the knowledge of inflammable gas first collected and shewn by Mr. (or Sir James) Lowther, and in 1736 by Mr. from solution of iron in acids, began to be greatly improved by Mr. Cavendish in particular; to whom the chemical world was first indebted for any accurate knowledge of the properties of this gas.

In France, chemistry was cultivated with more assiduity than in England by Geoffroy, Lemery, the two Rouelles, Macquer, and Beaumè. No work ever published, has so much contributed to render chemistry popular, as the chemical dictionary of Macquer, which is a faithful register of facts, by a man of great knowledge, great modesty, and singular good sense. From the publication of this book, chemistry became fashionable, and its votaries, and its facts, received a daily accession. In England about the same time, Dr. Lewis of Chelsea, contributed much to advance the science in that country, by the experiments contained in his Commercium philosophico-technicum, and by the establishment of the crucible manufactory there, under his protection. Mr. Chisholme, Dr. Lewis's operator, on the death of the doctor, was engaged by the late Mr. Wedgewood, to make experiments in pottery : and the great perfection of Wedgewood's ware, is probably owing in no small degree, to this enlightened proposal of Mr. Wedgewood himself; who always kept in full employ, an establishment for experiments, distinct from his regular work.

We have arrived now to the times of modern chemistry, and to discoveries that have changed the face of the whole science.

The dissertations of Mayow had lain dormant, unnoticed and in fact unknown, when Dr. Priestley in 1771 discovered the same kind of air in nitre which Mayow called his aerial spirit of nitre: in the summer of 1774 he procured the same air from the oxyds of lead and of mercury, and detailed the properties of it to the Royal Society, and also at the table of Mr. Lavoisier in the same year, and in the laboratory of M. de Trudaine. About the same time the illustrious Scheele, a Swedish apothecary, discovered the same air and many of its properties, without any knowledge of what had been done by Mayow or by Priestley. Soon after, Lavoisier disgracefully claimed to have been also a discoverer of the same gas, but that question is now settled not to the honour of his memory by the philosophers of Europe. To enumerate the new substances brought to light by Scheele, and the equally numerous facts by Dr. Priestley, who may truly be stiled the father of pneumatic chemistry, would occupy of itself a lecture. Scheele and Bergman led the way to modern analysis, and Priestley, Black and Cavendish to the doctrine of airs: and it is not a little to the honour of these philosophers, (of Scheele and Priestley in particular) that their discoveries were made with the simplest and cheapest materials, and by means of apparatus within the reach of very moderate circumstances. It is true, that affluence as in the cases of Cavendish and Lavoisier, is of very great advantage in devising and conducting experiments; but such men as Scheele and Priestley, possess resources of much higher moment.

Truth has obliged me to remark (8.) that Lavoisier's claim to a participation of the discovery of oxygen does not rest on a foundation honourable to himself. When Dr. Priestley exhibited it at Paris, in October 1774 to Mr. Lavoisier, Le Roy, Macquer, Trudaine and others, Lavoisier was as much surprized as the rest. But notwithstanding this unfounded claim, he cannot be deprived of the honour of that most ingenious train of reasoning, and that accuracy of experiment, which first of all ascertained the true nature of calcination and combustion—which introduced a precision of induction as well as of experiment, unknown before—which led to the discoveries of the composition of nitrous acid by Mr. Cavendish, of water by the French chemists, of ammonia by Dr. Austin and Milner—which raised the French theories triumphant over the prostrate doctrine of phlogiston—and which has made the French nomenclature, the universal language of the chemical world. I well know that the papers of Mr. Lavoisier in 1776 contained a developement of the theory of Jean Rey, who had many years before suggested that the accession of weight observed in the calcination of metals, was owing to an absorption of air: but there is no proof of Rey's works or his theory, having been known to Lavoisier, or indeed to any of the chemists of the day. He was like Mayow, forgotten, or neglected. Moreover, it is not the mere suggester of a fact, a theory, or a principle, that is entitled to the merit of it. Those only can claim the honour of a discovery, who by well conceived processes of experiment and reasoning, bring it fully into day, and enable others to pursue the same path, and make additions to the knowledge so given to the world: and this did Lavoisier. As practical chemists, I greatly doubt if the French are equal, and certainly they are not superior to the British; among whom, the practical chemistry of the arts and manufactures, is advanced fifty years at least beyond the same state of things in France: but the talent for ingenious reasoning, and enlarged views of scientific theory, belongs to the French in an eminent degree.

It was to the strict attention that Lavoisier paid to weights and measures, as well as to the ingenuity of his experiments and reasonings, that the ultimate prevalence of the French system may be attributed. Scheele and Dr. Priestley, had not sufficiently attended to the accession of weight which metals receive during calcination;

they looked too exclusively at their revivification by phlogistic processes, and the very fine experiment of Dr. Priestley of reviving metallic calces in inflammable air by a burning lens, seemed for a time to establish the theory of phlogiston by an experimentum crucis.

Jean Rey as I have already noticed, had before shewn that metals gained in weight by calcination, and attributed it to the absorption of air; but Lavoisier with an acuteness and address hitherto unexampled, shewed that in every case, the calx (or as we now call it the oxyd) of a metal, was the metal itself, combined with the air called by Scheele empyreal air, and by Priestley dephlogisticated air: that this air might be expelled by heat and recovered; that added to the weight of the metal, it made up the weight of the calx: that it might be again united to and impacted in the metal, which would again be calcined by the process, and that there was no necessity for any recurrence to inflammable air, or phlogiston, to explain so simple a process. He shewed that this air united to the basis of acids formed acids, as with sulphur it formed the acid of vitriol, with azot the acid of nitre, with oxyd of arsenic the acid of arsenic, and so forth.

He shewed also the precise composition of atmospheric air, that it consisted of an intimate mixture of this pure air and azot, or an air unfit for the support of life; being indeed a mixture of the component parts of nitrous acid, but not in the same strong chemical union.

He and the French chemists upon this foundation, formed with great labour, and equal ingenuity, a new chemical nomenclature, intended to be descriptive of the composition or characteristic properties of the substances to which they gave names: wherein the part of atmospheric air that supports life and flame, and gives acid properties to the bases of acids, they called *oxygen*: the other part of the atmosphere, because incapable of sustaining life or maintaining combustion, they denominated, not however, with characteristic accuracy, *azot*.

The great objection to this nomenclature is, that being founded on the theory of a particular period, it tends to perpetuate the ignorance and error of the period; nor can it be thoroughly accommodated to all the new facts which the course of chemical investigation, even yet in its infancy, may from time to time bring forward to the day.

Within these two years, the brilliant discoveries of Mr. Davy of the Royal Institute in London, have thrown a cloud over the whole of this theory, and the modern language of chemistry; and given us good reason to believe that oxygen so far from being exclusively the base of acidity, is also the base of alkalescence: and as new facts turn up, discordant with the theory, they will require a correspondent alteration of the language. What those discoveries are, I shall have occasion in the course of the lectures to explain and exhibit, so far as the apparatus will allow me. Some observations on the discoveries relating to heat, will close the outline of this history of chemical science; which to be treated as it ought, well deserves a volume for the purpose.

Bacon, Lord Verulam, who died in 1626 set an example of his general theory of building philosophy on the foundation of fact, by a treatise *De Formâ Calidi:* wherein he collected all the known facts on the subject of heat, and from a consideration of these, he drew the conclusion that heat consisted in motion. This opinion he founded chiefly on the phenomena of heat produced by percussion, collision, and friction. This opinion was adopted generally by the English philosophers; by Boyle, by Mayow, and by Newton, and until within these thirty years. Boerhaave published a dissertation on heat, of great value for the extensive and accurate enumeration of the facts, which led him to doubt the then prevalent doctrine of heat, as consisting in the vibration or violent intestine motion of the particles of the heated body. He considered it as a peculiar matter, pervading all bodies, and giving rise to the phenomena of light and electricity as well as heat. In the year 1762, Dr. Black promulgated his theory of latent heat, that is, of heat chemically combined with the heated body, but not apparent, or capable in that state, of being made sensible to the thermometer, or to the human feeling. He shewed distinctly, that heat was absorbed from other bodies in contact, and chemically united with the heated body, when solids were converted into fluids: when ice for instance was made water, and water vapour, and vice versâ; and that this was the case, when the temperature by the thermometer remained the same. This theory was pursued and illustrated by his pupil, Dr. Irvin, and by his friend Mr. Watt of Birmingham; who applied it to the phenomena of the steam engine, with unexampled ingenuity and success. Dr. Crawford also, made some very ingenious experiments on the capacity of bodies for retaining heat; and shewing that the capacity of oxygen being greater than that of any other known body for heat, he ascribed to this part of the atmosphere absorbed by the bl od through the coats of the bronchial vessels of the lungs, the phenomena of animal heat. Dr. Priestley's very simple but beautiful experiment of the absorption of oxygen by venous blood through the substance of a bladder, led to this as well as to Dr. Goodwyn's theory of asphyxy, and many other facts and deductions of great importance, with which physiology has been enriched. It is hardly necessary, however, in accounting for the heat of the animal body, to confine the explanation to any one process, as heat must be given out every moment of our existence, in consequence of the various processes of digestion and secretion perpetually going on, within the laboratory of the human frame.

The materiality of heat, however, first began to be considered as established by Scheele's experiments on the transmission and radiation of heat; and the subject has been since so well prosecuted by M. Pictet of Geneva, and by Mr. Leslie, that I think we may fairly venture to say, that a substance capable of being intercepted, when the light that accompanies it is transmitted; of being itself transmitted; a substance capable of radiation, of reflection, of refraction, of being chemically combined and chemically extricated; and which according to the experiments of Herschell and Sir Harry Englefield, belongs in a peculiar degree to particular rays of light, is a substance sui generis, and not merely an ens rationis, the mere effect of a modification of motion. With respect to light, we know as yet little about it. The doctrine of Euler is not yet exploded, and indeed I cannot conceive how any person who ever lighted a candle by means of a tinder box, can agree with the prevalent opinion that light is dependent on the sun alone.

Count Rumford's experiments throw some obscurity in appearance over the theory of the materiality of caloric ; and Mr. Davy of late, seems inclined to doubt the modern notions concerning heat ; but we shall be better able to judge of the value of his conjectures, when they rest on a broader basis of experiment.

Modern experiments render it necessary to take at least a brief notice of GALVANISM.

Lewis Galvani born at Bologna in 1737, died in 1798. In the year 1789 he discovered, that if a piece of metal was brought in contact with the limb of a frog recently dead, exposed at the same time to the influence of electricity, it threw a muscular fibres into convulsions. He afterward ascertained, that the same effect was produced by touching the muscle and a nerve of the frog with pieces of different metals brought into contact at the other end, either immediately or by connecting the two metals by means of a metallic circuit. He found zinc and silver, or zinc and gold, answer best for the purpose. He concluded that muscular irritability, was an electric phenomenon.

The subject was pursued by Messrs. Valli, and Volta, and Drs. Fowler and Monro. Volta found, that by placing several pieces of zinc and silver, each about the size of a crown piece, one on top of the other, only separated by pieces of the same size, of flannel dipt in salt and water, he could constitute a battery capable of giving a shock similar to that of electricity; and that the two metals in this process were in opposite states of electricity. He varied this pile, (called after him the Voltaic pile,) by placing alternately plates of zinc and silver connected by an arc of metallic wire, in tumblers filled with salt and water.

In 1800 Messrs. Nicholson and Carlisle observed that in galvanic experiments a kind of gas was given out; which they afterward ascertained was owing to the decomposition of the water in which the wires connected with the top and bottom of the Voltaic pile were immersed. And pursuing these enquiries, they found that in fact the water was decomposed into oxygen and hydrogen, in the proportions previously ascertained as necessary to constitute water; the oxygen being evolved by the wire connected with one end of the pile, the hydrogen by the other. These experiments were further pursued by Mr. Cruikshank of Woolwich, who decomposed not only water in this way but the muriat of lime and soda, and the hydrat of ammonia. To him we are indebted for the galvanic trough, which is now made of common queensware and porcelain; divided into compartments, each containing alternately a plate of zinc and of silver, or of copper well plated with silver and connected by silver wire at top. The mixture best adapted for the experiment, is found to be, water about nine tenths, and nitric acid one tenth. The intensity being greatly proportionate to the speedy oxidation of the metal. Dr. Henry of Manchester pursued these experiments with great success, and decomposed galvanically the sulphuric and nitric acids, and ammonia. With such an apparatus (which may conveniently consist of about 100 pairs of plates of zinc and silver of about 6 inches square,) Mr. Davy has decomposed many of the neutral salts, as when muriat of soda has been exposed to galvanic action thus produced, the alkali was collected to one side and the acid to the other: so also were the component parts of solid gypsum, and of many saline solutions. Even briefly to mention the numerous facts ascertained by this laborious and very ingenious man would exceed the proper bounds of this lecture, but the most extraordinary of his experiments are those by which he has decomposed several substances heretofore deemed simple, the alkalies in particular, and shewn that these last are in all probability metals united to oxygen. The same thing has been done in a different way in France, by Gay Lusac and Thenard, who by deoxydyzing alkalies by red hot iron, have shewn also that they were convertible into metals: an experiment of the late Dr. Woodhouse went near to shew the same thing. These experiments lead to the conclusion, that chemistry is either a branch of electricity, or so intimately connected with it, that they will ultimately be found traceable to the same general principles.

The sketch proposed in this introductory lecture will require some brief notice to be taken of the progress of MINERALOGY, which I confess I am more inclined to consider and to treat of as the handmaid—as the short hand of chemistry—than as a science that ought to be rested on an independent basis: particularly in the present very imperfect state of knowledge respecting it, of the means of classification, of the uses to be derived from it, and above all from the consideration of what the state of knowledge and education in this country peculiarly calls for among us. I well know that much assistance is to be obtained from the features of a mineral, and the forms of a chrystal, but we want at present in this new land, chemists, miners, and practical mineralogists, more than chrystallognosts.

With respect to mineralogy, Theophrastus, Dioscorides and Pliny, contain every thing that ancient writings furnish; for the supposed treatises of Orpheus and Democritus on stones have not reached us: and that every thing, is very little: a bare enumeration of certain stones and some of their uses and properties, but nothing of system. George Agricola already mentioned, who flourished somewhat before the middle of the 16th century, seems to be the first writer on the subject, who treated it regularly and methodically: indeed the mountainous and mining countries of Saxony and Sweden, are the places to look for the first notices of this science. The ancients divided their elements into air, fire, water and earth. Agricola divides mineral substances into earth, concrete juice, stone, and metal. Hieronimus Cardanus about the same time wrote on the subject, and separated the saline from the inflammable bodies. Kentman in

1665 added petrifactions. Before this, in 1609 Boetius (Von Boot) had published an account of 600 precious stones. About the same time Alonzo Barba a Mexican priest, published on the subject, introducing the method of proceeding by amalgamation, which Baron Born some years ago brought into fresh repute. Aldrovandus compiled also a body of mineralogy. From 1650 to 1700 we have the works of Johnson, Notitiæ regni mineralis, Kircker's Mundus subterraneus, and the very accurate Woodward's treatise on fossils: his own collection, is now at Oxford, and is useful, and remarkable, for his exact description of the localities of every specimen.

John Joachim Becher already mentioned, in his Physica Subterranea, first proposed a chemical classification of minerals, and he first divided metals into perfect and imperfect.

Beyer, Buttner, and Scheuchzer were employed about the year 1740 to 1750, in the arrangement of petrifactions and illustrating the proofs of the general deluge, by the remains of the antediluvian animal and vegetable creation, scattered so promiscuously over the face of our present globe. A subject, that Dr Parkinson it is to be hoped will still further illustrate, when he has completed his Organic remains of the antediluvian world. This discussion and arrangement of petrifactions, necessarily suggested an examination of their localities, and the kind of mountain and rock in which they were found: and this led the way to the study of geology and geognosy. Von Bromel published a mineralogy in 1739, and Cramer, already well known for his Docimasia, in 1739 published another; dividing bodies, into metals, semi metals, salts, inflammables, stones, earths, and waters. A division certainly more complete than any preceding. Three years before, the great Linnæus embraced mineralogy in his catalogue raisonnèe of natural bodies; but with far less knowledge and success than he pursued botany. Yet the systematic classification which that extraordinary man introduced, suggested improvements, and more exact descriptions in mineralogy. Pott and Henckel added much to the chemical part of mineralogy. Wallecius, in 1747 published a mineralogy with more accuracy of description and more labour in giving the synonimes, than preceding writers. To him in 1758 succeeded Cronsted, whose mineralogy has been very usefully translated and commented on, by M. de Magellan. Sir John Hill in England, a second Psalmanazar, who published and forged on every thing, from Hannah Glass's cookery and the elixir of Bardana, to the grand tour of Europe, and the trees of the forest, wrote also on mineralogy; giving tables of external characters superior to those of Pothner who preceded him: though incessantly writing for the booksellers, and compounding quack medicines for the populace, composing books of travels for circulating libraries, and cookery for the housekeepers of families, he certainly was a man of great industry, great knowledge and of great utility in his day: and his insults on the Royal Society who rejected him, may be forgiven, not merely for their wit, but for no small utility in the reproof of inaccurate and puerile pursuit.

We come now to the period when the three systems of mineralogy which as yet divide the opinions of those who pursue that science, began to be promulgated to the world. I mean mineralogy as founded on chrystallography: mineralogy as founded on chemistry, and mineralogy as founded on external character.

Linnæus I believe first noted a distinctive character in the chrystallization. Nor was it entirely neglected by Werner: but Bergman and Gahn first suggested that every chrystal had a primitive form, being the last indivisible chrystal that formed a nucleus to the supervening chrystallizations.

In 1783 Romè de Lisle published his chrystallography. He divided his objects into saline, stony, metallic and semi metallic chrystals; and divides all the primitive forms into, the tetrahedron, 2, the cube, 3, the octahedron, 4, the parallellopiped, 5, the rhomboidal octahedron, 6, the dodecahedron with triangular planes: and he considers all minerals that agree in chrystallization, hardness and specific gravity, as of the same species. This system, greatly extended by the Abbe Hauy, now promises fair, to become the prevailing guide to mineralogical classification. For the purpose of ascertaining a mineral, the Abbè relies not chiefly on its chemical composition, on its specific gravity, hardness, softness, smell, taste, colour, &c. but 1st. on the general form and character of the chrystal, it exhibits, and the measure of its angles: 2. By pursuing its places of junction or apposition, he arrives at length by dextrous mechanical division to the ultimate chrystal it affords, without any further appearance of juncture or fracture; and this after Bergman and Gahn, he calls the primitive chrystal, the form and angles whereof he determines by the goniometer, an instrument made for the purpose, of measuring the angles of small chrystals. He shews with very great ingenuity the manner in which the same integrant molecules or primitive chrystals, may put on different appearances from the accidental disturbance of their original chrystallization—by the regular bevilling, or truncation of their angles—by the compression of their sides—or the decumination of their terminations. In this way, he and the disciples of his school, it must be acknowledged, have detected identity and difference of minerals, not obvious from their chemical properties, or their other external characters: and it certainly promises to impress more of a character of science on mineralogy, than it had before. But there are so few minerals which can be divided down to the primitive chrystal—there is so large a proportion unchrystallized—so many minerals obviously different, appear to have the same form of chrystallization, if not of integrant molecule—and the degree of manual dexterity required, is so much more than can usually be employed, that the system seems not calculated for common and popular use. This however is the prevailing not to say national system of France.

Werner proceeds in a different way. He first arranges all the possible external characters, of colour, transparency, taste, smell, touch, hardness, moisture, viscidity, flexibility, fragility, ductility, fracture, form as round cylindrical square amorphous, &c. &c. and then describes his mineral accordingly; trusting little to chemical character, and less to physical character, (as whether the mineral, be magnetical, electrical, singly or doubly refractive, and so forth) and less still to what he calls the empirical character deduced from its locality, accompaniments, uses, &c.

This system of external characters is so well arranged by Werner, that till lately it was deservedly regarded as the most useful yet known. The objections to it are the want of connection between minerals for the purpose of classification, the great number of marks of description necessary to each mineral, its being at best an empirical nomenclature, useful indeed to miners but containing nothing that can strictly be called science. The German mineralogists however, certainly in practice the best in Europe, conform to the arrangement of the school of Frieburgh, where Werner has long taught.

In England, the science of mineralogy made very little progress till within these five years past. Magellan's translation of Cronstedt was little attended to. Kirwan's first edition of his mineralogy, very meagre as it was, excited some attention, but his bookseller Elmsley in my presence told him, that there were not 300 readers of chemistry at that time in Great Britain. There are certainly many more than 3000 now. By means of Werner's system applied to Leske's collection now in Ireland, the second edition of Kirwan was very much improved, but there is as yet no national work on mineralogy. Jameson copies Werner; so does Thompson nearly; Babington, Accum, Kidd and Clark, are founded chiefly on chemical distribution, so is Kirwan's. Babington's had great merit, in my opinion at the time of its publication. For my own part I see much that is wanting in chemical arrangement, but after considering the classifications of Werner and Hauy, they seem to me liable to so many objections that I shall for the present adhere to some chemical arrangement, without pretending that this or any other arrangement can be permanent, in a science which was comparatively unknown but a few years ago. (49.)

With respect to Geology, which was almost untouched till Werner arranged the series of formations that constitute the great features of his Geognosie, I confess I should begin with the less scientific but plainer treatise of Kirwan, and stop short at the general arrangement of rocks, into primitive, transition, floetz, alluvial and volcanic; without bewildering a student with the numerous formations which the German mineralogist thinks he has distinctly traced: for I doubt whether they will admit of verification on our own continent. I have endeavoured to understand the theory of Werner, and to compare it with facts here, but I find myself with few opportunities of observation, so much at a loss, that if I were not conscious of my present inability to decide, I should certainly say, that fancy had something to do with his formations as well as fact; and that what may be true among the mountains of the Hartz, does not hold in the chains of the Blue ridge, and the Alleghany. But of this subject I speak with diffidence, till I have more opportunities of comparison and reflection, than have yet fallen to my share. Enough for the present, (I hope not too much,) of the history of chemistry, mineralogy and geognosy. I shall beg leave to close this introductory lecture with some observations on the uses of chemistry.

This is a part of the subject I might perhaps spare: for what branch of knowledge is not useful? In what does the noble nature of man differ from the brute, but in his capacity of acquiring knowledge, ? the knowledge of the properties, of the uses, and of the hurtful qualities, of the beings with which he is surrounded; 1st. that we may be more profoundly sensible of the wisdom displayed in the arrangement of the universe. 2dly. That we may exert all our own faculties in converting to our reasonable use and benefit, every natural object within our reach; and 3dly. that by acquiring and communicating knowledge, we may acquire and communicate the means of happiness to every sentient being in this our sphere of action. "Knowledge is power," says Lord Bacon: and so too were the Romans compelled to acknowledge, when they had to contend with Archimedes at Syracuse. From the beginning of history to the present day, it has proved so. But it is more: knowledge is happiness also; for it gives us the *power* and *the pleasure* of doing good, not only to ourselves, but to others.

Every person is apt to overvalue the importance of the pursuit in which he feels himself particularly interested. Yet I think it can be shewn, without much difficulty, that chemistry is of more immediate and useful application to the every day concerns of life—that it operates more upon our hourly comforts, than any other branch of knowledge whatever.

The arts and trades of life, depend partly upon mechanical, partly upon chemical operations. More upon the later. Let us briefly pass some of them in review. Agriculture, the first of arts, depends greatly upon chemistry. I say nothing of the iron manufacture, of the plow and the harrow, and the ax and the spade. But agriculture will never be at its perfection till the knowledge of soils, and the relative value and operation of manures shall be much more common among practical agriculturists than it yet is. The plants that answer for a clay, or a loam, will not suit a sand, or a limestone; nor will the same manures have the same effect in every soil: nor can a farmer without some chemical knowledge, form any accurate idea, how one soil isto be manured by another. Of the artificial manures also, it is necessary a farmer should know how they act, and their proportions: thus, some manures are mechanical, either encreasing or decreasing the adhesiveness of the soil, and its capacity for retaining moisture, as sand to clay, or clay to sand; some are manures of stimulus, in which the quantities must be strictly attended to: thus, a dozen bushels of salt will be a septic and a condiment; so will a couple of bushels of gypsum per acre; but 60 bushels of salt, or half a dozen of plaister of paris, will render sterile, the acre proposed to be fertilized. Others are chemical manures; as lime and ashes, which decompose noxious minerals; and are moreover the specific stimuli of certain plants, as white clover and potatoes. Other manures are manures of nourishment; furnishing a pabulum to the vegetable, either of carbon, or azot; such as putrid animal and vegetable substances; which by vegetable organization are capable of becoming vegetables again; and those vegetables by animal organization, become animals again: so true is the saying of the psalmist "all flesh is grass." Indeed, nothing seems essentially necessary to a vegetable, than the gases, the water, the alkali, and the iron, of which it is composed, but some substance in which it can be kept firm, and imbibe freely, oxygen, hydrogen, and the solar light. To encrease its size, manures of stimulus seem alone necessary.

What were physiology and pathology, or what was medicine, till the facts of pneumatic chemistry and the application of chemical remedies threw light upon the one, and gave origin to the other? Even while I am writing this, chemistry holds out to view in magnesia, something like a specific for gout and stone.

Of the manufactures which contribute to the comfort or the ornament of society, I do not know one that does not for the most part depend upon processes purely chemical: The analysis and smelting of ores; the manufactures of iron and steel; of copper and brass; and silver and pewter; the manufactures of leather, glass and pottery; of soap and candles, of drugs and medicines; the bleaching, the dying, and the printing of silks, cottons, linens and woollens; the printing of furniture paper; the composition of printer's ink as well as of common ink; the manufacture of parchment and of paper itself; the arts of silvering and gilding; of colour making; the manufactures of wine and vinegar; baking, brewing and distillery; even that most useful art, the art of Cookery, is very greatly indebted to chemistry: for independent of the late improvements of coating copper vessels with zinc, silver and platina, instead of tin; and iron vessels with white enamel; the whole art of cookery has undergone an economical revolution by the experiments of Proust, Rumford, and the scientific gentlemen who superintend the benevolent soup establishments of England. One fourth of the meat, and three fourths of the fuel, heretofore wasted, can now be saved. The application of steam to cookery, now so common in England, is almost unknown in this country; and still further improvements, not merely in the economy of our kitchens, but the sapidity of our viands, may reasonably be expected, not from ignorance, prejudice or accident, but from science; certainly well and usefully employed, while contributing to the every day comforts, and every day, savings of the rich and of the poor.

Swift was right when he said, "that man deserved a "statue to his honour, who made two blades of grass grow "where only one grew before"; and so does he, who makes a given quantity of food, support with equal benefit, twice the number of people.

Until these last forty years, chemistry could hardly be called any thing but a collection of detached facts: much indeed was known in the workshop of the manufacturer, and much by the experimentalist. But until the popular compilations of Macquer and Beaumè in France, the rapid and important discoveries of Scheele, *Priestley*, Cavendish, and Black, and the beautiful system of Lavoisier, chemistry could hardly be called a science: for it had ascertained no laws, by which traditionary processes could be explained, or material improvements suggested. Let any one examine the state of the arts and manufactures, fifty years ago, and compare it with the situation of the present day, and it will be found, that during these fifty years, more improvements have been made, originally suggested by chemical theories, and pursued under the guidance of chemical knowledge, than in two thousand years preceding. At present, there is not a manufacturer of note in England, who is not more or less acquainted with chemistry as a regular branch of education and study. Indeed, the benefit that country has received from the scientific views, and great knowledge of a few men eminent for their practical skill in mechanics and chemistry, baffles all ordinary calculation: I am fully persuaded, that the gain which has accrued to that nation, from the Duke of Bridgewater's Canals, Sir Richard Arkwright's cotton spinning, the pottery of Wedgewood and Bentley, and the steam engines of Bolton and Watt, was much greater than the whole expence of the American war.

So in France, the chemical knowledge of Paris, enabled the nation to defend itself against the combined forces of Europe, by furnishing in one twelvemonth by means of eleven hundred pupils, sent from the provinces, more cannon, and more saltpetre of home manufacture, than was necessary even to the prodigious consumption of that time. I believe it is true, that they did not depend on artificial nitre beds, or the putting in requisition the walls and floors of stables and cellars, but made some practical use of Dr. Milner's fine experiment of decomposing ammonia by red hot manganese: still however, the resources of the country at that period, depended on the science of the chemical philosophers at home, as much as on the skill of the generals abroad.

It is to superiority of knowledge, that the same enterprizing people owe their present conquests. It is to science chemical and mechanical, that England is indebted for having made her Island the storehouse of the world, for having compelled the nations of the earth to pour into her lap their superfluous wealth, for having acquired the undisputed command of the sea; and of whom it may truly be said in the language of the prophet, "her merchants are as princes." Nor is it otherwise than in the common course of human nature, that two nations who nearly divide the knowledge of the world between them, should nearly divide between them, the world itself.

In fact, the three greatest conquerors known, have been literary men. I speak not of the almost fabulous histories of Ninus, Sesostris or Semiramis, nor do I allude to the savage incursions of Kouli Khan, or Aurungzebe; but of ALEXANDER the great, of JULIUS CESAR, and of BUONAPARTE.

It is not on his conquests that the true fame of Alexander is founded, who was not ashamed to adopt Homer as his favourite author, and to acknowledge Aristotle as his friend. It was on the scientific character of his tactics, on the able men he selected about him, on the care he took to extend the bounds of knowledge, by carrying with him as a part of his establishment, not only historians to record the transactions they witnessed, but able geographers and mathematicians. It was for exploring the countries he went through as a conqueror, with the eye of a man of science; sending out engineers by land, and expeditions by sea, to ascertain the internal character and features of the country, the coasts, the harbours, the bays, and to mark the situations that admitted of future use or improvement, either for the aggrandisement of his own power, or the benefit of the people he subjected to his sway. It was for pitching with admirable foresight on one of the most eligible places in the world as it then stood, as a commercial emporium, Alexandria—for introducing Phenician manufactures, and extended commerce—for improving every means of internal communication for promoting to great expence all the means of propagating knowledge (50.) and for looking forward to consult the future prosperity of the kingdoms he was to leave behind him.

Of Julius Cæsar, we all know that in every part of his life, in his daily habits and demeanor, he shewed himself the accomplished gentleman, the distinguished scholar, and the friend of learning and learned men.

And in what way has the present extraordinary man, who rules the destinies of France proceeded? His moral conduct indeed, no moral man can venture to approve, but his abilities, no able man can refuse to admire. Conversant himself with mathematical and chemical knowledge, he sedulously encourages every institution for the promotion of science; and publicly boasts of the chemical exertions of the national Institute, as a striking mark of national prosperity. A branch of that institute consisting chiefly of the professors of chemical and mathematical science, was attached to the establishment of the army of Egypt, and it must be acknowledged that we now possess in various ways, more accurate knowledge of the ancient and present state of that interesting country, than we could at any time have looked for without these aids. Abroad, while his army is not fighting, his officers are studying; for it is well known that every encampment comprehends a vast establishment of education, and scientific improvement; and greatly must his success be attributed to the knowledge, the skill, and the accuracy of his numerous corps of engineers. (11)

In every sense of the word therefore as a practical, as well as a philosophical maxim, KNOWLEDGE IS POWER.

Not only that knowledge of human affairs and of the human character, which displays itself as well in the prudence of common life, as in the arrangement and combination to the best effect of the qualities and forces of political communities—but that knowledge also, which subjects in the best possible way to the use and the dominion, of man, all the powers and properties of inferior animals and the vast range of inanimate nature. That knowledge, which multiplies a thousand fold, the physical force of a human being—which renders every hour of existence more desirable, by compelling every object around us, to contribute in some way or other, to our pleasure, to our profit, to our comfort, or to our convenience —which brings the mutual wants, and the mutual supplies of the inhabited world into immediate contact—and which multiplies not only human enjoyment, and alleviates human suffering, but multiplies also the human species; by providing more extensively, the means of constant employment, and comfortable subsistence.

It is knowledge then, that must render us respectable and respected; for those only who possess it are so, whether as nations or individuals. To acquire it, we must cherish and extend the means of acquiring it. If not, we may vainly boast of the advantages we fancy we enjoy, but they will ultimately fall to those who best know how to use them. May that day not arrive, when we shall be weighed in the balance and found wanting.

END OF THE LECTURE.

NOTES AND REFERENCES.

NOTE 1st. All new inventions are at first put in practice, in the most awkward and difficult manner. Simplicity of means and facility of execution, belong to the last stages of art. How many ages must have intervened before hieroglyphic was converted into alphabetical writing? In Egypt, the priests seem to have preserved hieroglyphic writing for their akroatic or esoteric knowledge. The Chinese letters seem less removed from hieroglyphic writing than any other. Long after Cadmus introduced alphabetic writing into Greece, the *Boustrophedon* method continued in use, wherein the first line being written forward or from left to right, the next line was written backward, or from right to left: the second line beginning under the last word of the first. The laws of Solon were thus written and published. (Potter's Archæologia Græca l. 1. ch. 26, a book more learned and exact, though not so amusing as Barthelemi's Anacharsis.)

Lord Elgin who was appointed ambassador extraordinary to the Ottoman Port, in 1799, has rendered great service to the arts, by his numerous, accurate and expensive collections, measurements, and drawings, brought into England, from Greece and other places; where the monuments of ancient art, are daily disappearing through the ignorant ravages of the Turks. From the memoranda of his pursuits in Greece, lately published, it appears, that he has secured the celebrated *Boustrophedon* inscription, from the promontory of Sigæum, which Lewis the 14th in vain attempted to procure. His lordship has also procured from the Opisthodomos of the Parthenon (or Hecatompedon, one of the temples of the Acropolis at Athens) some valuable inscriptions written in the manner called *Kionedon* or columnar; next in antiquity to the Boustrophedon. These inscriptions contain an equal number of letters in each line, which range perpendicularly as well as horizontally, rendering interpolation almost impossible.

The history of the transition from hieroglyphic to alphabetical writing is well observed on by Bishop Warburton, in his divine legation of Moses; by Dr. Priestley in his lectures on grammar; and in the late dissertation of Mr. Marshman, on the Chinese language, so far as I can judge of it, from Quart. Rev. May 1811, p. 372. The first notice of writing in the Bible, is in 17 Exod. 14. previous to the delivery of the tables of stone from Mount Horeb. The writing of a book is also mentioned in 31 Job, 35.

NOTE 2. Herodotus (Euterpe 142) and Plato, were, certainly deceived by the Egyptian priests, whose chronological frauds, as Sir Isaac Newton observes (Chronology p. 6.) did not escape Diodorus Siculus, who controverts their ten thousand years of regal and priestly succession, as founded on manifest imposition. As to the fables of the Chinese, and the modern Hindoos, mythological and historical, they outrage common sense too palpably, to afford the slightest ground of belief. But in rejecting their Avatars, and their hundreds and thousands of years of ancient history, it does not appear to me that we have a right as yet to reject the æras apparently founded on *astronomical observation*. This question has been well discussed, as it well deserves to be, by M. Le Gentil, in his Voyage dans les Mers de l'Inde; M. Bailly in his Traitè de l'Astonomie Indienne et Orientale, and by professor Playfair of Edinburgh in the second volume of the Edinburgh Transactions, who are in favour of the high antiquity of the Indian Tables—

and by Dr. Marsden in the Philosophical Transactions for 1790, and Mr. Bentley in the 6th and 8th vol. (quarto) of the Asiatic Transactions, in his remarks on the antiquity of the Hindoo rule of calculation, the Soorya Viddyantes, or Sooria Viddantam; who dispute them. M. de la Place is not quite satisfied that the observations registered in the Hindoo tables of Astronomy, were actually made 3102 years before the Christian æra, at the Indian period of the Kaly-Youg; but is nevertheless willing to admit of such observations, at a period even earlier than that. The following is a very brief sketch of the controversy.

The gentlemen who adopt the period of the Kaly-Youg, shew

1st. That at various times, and without the possibility of communication or preconcert, four sets of astronomical tables have been transmitted to Europe from different parts of the east.

M. de la Loubère, ambassador from Louis XIV to Siam, brought home from thence in 1687, tables and rules for the calculation of eclipses. He found also in the place where the naval charts were kept, two manuscripts containing Hindoo astronomical tables deposited there by M. de Lisle then deceased: of these tables, one set was presented to M. de Lisle by Pere Patouillet correspondent of the missionaries in India, the other came from Pere Duchamp who procured them from the Bramins, at Krisnapouram, or Chrisnabouram (for there is no settled rule of spelling or pronouncing Hindoo names.) The tables given by Pere Patouillet, are presumed to have come from the neighbourhood of Narsapoor, a town belonging to the English in the northern Circars, as they contain a rule for determining the length of the day, for latitude 16° 16′ north.

In 1772 M. Gentil brought home other tables of Hindoo astronomy procured from the Bramins at Tirvalore, a town in the Carnatic, in lat. 10° 44′. These four sets of tables, were deposited with the Academy of Sciences at Paris. All these tables appear calculated for meridians not far from Benares, the great depository of all Hindoo science. The Siam tables, suppose a reduction of one hour and thirteen minutes of time, or 18° 15′ of longitude, which refers to the meridian of Benares. The Tirvalore tables, correspond with the Hindoo æra, Kaly-Youg, or rather 27 hours 32 minutes and 30 seconds after it, or 18th Feb. at 6 in the morning 3102 years A. C. The Kaly-Youg, commencing on the 16th.

2dly. The tables of Siam sent over in 1687 imply astronomical knowledge unknown in Europe, until the publication of the tables of Cassini and Mayer many years afterward that date.

3dly. These tables, assign values to nine different astronomical elements, which do not belong to them at the present day, but which the theory of gravity proves to have belonged to them at the æra of the Kaly-Youg: Viz. *The inequality or procession of the Equinoxes*, which they calculate at 54 seconds a year, whereas the motion of the stars from west to east is found at present to be only 50 seconds a year—*the acceleration of the moon's motion*, which according to Mayer is about 9″ more in one age than in the preceding; this in 4801 years would amount to 5° 45′ 44″: making this correction, the difference between the moon's true place at the commencement of the Kaly-Youg, and that assigned by the tables of Tirvalore is no more than 37′ the tables of Mayer giving 10° 6′ 37″ and the Tirvalore tables 10° 6′. This calculation could not be founded on the tables of Ptolemy at Alexandria, nor on the tables of Ulugh Beig at Samarcand, commencing July 4th, 1437, because they give different results. Nor on the Arabian tables, for the Arabians employed those of Ptolemy; and so did the Persians in their tables of Chrysococca and Nassireddin—a third element is *the length of the solar* *year*, which Bailly and Playfair investigate much at large—a fourth is the *equation of the sun's centre*, this which according to De la Caille is 1° 55½′ depends on the eccentricity of the earth's orbit which is subject to alternate diminution and increase. Making the requisite corrections, the Tirvalore tables will be erroneous but 4′ at the æra of Kaly-Youg: an approximation to truth, that late astronomical discoveries alone could have announced—a sixth element is *the place of Jupiter's Aphelion*. The methods of calculating correctly hereon, were not known in Europe till M. de la Place, the best astronomer now living, ascertained the periods of the mutual action of Jupiter and Saturn on each other, and the inequalities thence resulting. Making the needful corrections pointed out by modern discovery, the calculations of the Hindoo tables are precisely right---the *equation of Saturn's centre*---and the *inequalities of motion* in those two planets, stand upon the same method of proof.

To these may be added the following considerations.

1st. Mayer's tables I believe, first pointed out the small but regular acceleration of the moon's motion: Le Grange first shewed that all the variations in our system are periodical: and a full exposition of what is known concerning the apparent irregularities of the planetary bodies from their mutual action on each other, and the calculations thence indicated, we owe to Le Place in his larger work the "Mechanique celeste;" of which I observe a very instructive abridgement as it should seem, lately published, Exposition du Systeme du Monde, translated into English in 2 vols. by Mr. Pond of the Royal Society. (30 Ed. Rev. 354.) Hence the presumption is, that the observations in those tables must have been actually made; and not founded on any theory, or subsequent calculation: for no rules of calculation known either in India or in Europe, till of late days comparatively, would have enabled them to approach so near to the expression of real fact. The astronomical knowledge of 150 years ago, would not have led, but misled them.

2dly. All the late accounts of Indian knowledge, tend to shew that the most learned of the Bramins do not comprehend at all, the theory of the rules by which they calculate either mathematical or astronomical questions. I refer generally to the Asiatic researches and the Asiatic miscellany; where I know this remark is repeatedly made: but as I have not the books now at hand to consult, I cannot refer to the passages. So, Father *Du Camp* relates, that when the Bramins at Krisnapouram were at a loss, or committed mistakes, they used to say, "this would not have happened if we now understood the *Sooria Siddantam.*"

3dly. Much curious reasoning corroborative of Bailly and Playfair's arguments might be drawn from astronomical observations connected with the well of *Syene*, and the Zodiacs of Tentyra, (or Dendera) and of Esnè: for which see De Non's travels, large edition, and Hamilton's Egyptiaca. The accounts also that we have of these tables, corroborate, and are corroborated by the account given of the Babylonish tables sent at the command of Alexander by Calisthenes to Aristotle. These reached as is said to 2234 years before the Christian æra, and were 1903 years earlier than the incursion of Alexander. Taking for granted the inclination to forgery in this respect, how happens it, that all these forgeries at various times, and at various places, by learned men, not communicating with each other, should all coincide in exhibiting a correctness of astronomical knowledge, hardly yet possessed by European Astronomers?

Dr. Marsden, and Mr. Bentley object,

That according to M. Bailly's own calculations, there could not have been at the moment indicated by the tables of Tirvalore, a conjunction of all the planets, for there was no less than 73 at that time between the places of Venus and Mercury, which is not compensated by shewing that when the sun and moon were in opposition 15 days after, all the planets but Venus being comprehended in the space of 17° might be visible. This argument is also strengthened by similar observations of Le Place. To which no reply is obvious excepting that the expression of the tables is general, that there was a conjunction of the planets, without saying of all of them.

2dly. Dr. Marsden says that both Le Gentil and Bailly are egregiously mistaken in their supposition of the Hindoo method of calculating by cycles of 60 years, and that their theory of this calculation does not coincide with the date of the Kalee-Youg which began in the 13th year of the cycle, 60.

3dly. Mr. Bentley in his examination of the Soorya Siddyantes, or Hindoo system of astronomical computation, makes it comparatively of modern origin; and concludes that the calculations of the tables were made backward by theory, from the date of some accurate and actual modern observations. For his calculations on this head, the reader may consult the 6th vol. of the Asiatic Researches, and his reply to objections in the 8th vol. of the same work.

4th. An objection has been taken to this supposed antiquity of the Hindoo calculations from the Mosaic account of the Deluge. Whether that event was universal, covering every part of the earth at one and the same time, as the literal expressions of Moses certainly imply, has been doubted and controverted; on the ground, that we are not compelled to understand the Mosaical account to relate to any part of the earth but what was known to Moses at the time. Doubtless, the marks of the sea having at some time or other covered the land, are to be found in almost every climate and latitude of our globe. Most of the deluges noticed in profane history are partial. Mr. Kirwan who has published a very learned defence of the Mosaic account, treats it as a case that includes a dignus vindice nodus, and disclaims all explanation but what is grounded on an exertion of miraculous power at the time. Wherein doubtless he is right. I wish howver in the next edition of his Geology, he would explain the fact noted by himself that no secondary mountain rises more than 6000 feet above the level of the ocean. I do not think Cuvier's remark stands much in the way, viz. that in the caves of the great chain of calcareous mountains extending for 600 miles, nearly from the Hartz to the plains of Hungary (which I do not apprehend to be primitive) there are no bones of marine animals, or any thing that marks the presence of the sea.

However, this is a question connected with theological considerations, wherewith as a chemist I have nothing to do. Nor does the objection stand at all in my way. According to the computations founded on the Septuagint, the interval from the creation to the Birth of Christ, comprehends 5872 years. According to Eusebius and the Septuagint, the interval from the creation to the Flood was 2242 years. Hence the æra, Kaly-Youg, or 3102 years before Christ, will be 528 years after the flood. Nor is it to be supposed, (adopting the Mosaic account of the deluge) that no traces of former knowledge, were retained by Noah and his family. This will leave time enough for a series of observations in an eastern climate, on which the tables in question might have been grounded. The faulty chronology of the Hebrew text, has been the real parent of this difficulty.

Such is the best view I can give of the arguments on both sides of this very curious, but very knotty question.

An extract from La Place on the subject, may be found in 30 Ed. Rev. 371. and a view of this controversy somewhat different from mine and of which I have made no use, in 8 Dobson's Encyc. 519. The preceding objection drawn from the universality of the Mosaic Deluge however, belongs I believe to the compiler of that article, who might have spared himself the trouble of stating it, had he duly attended to the most authentic chronology of the Mosaic history.

"Non nostri est tantas componere lites." But as I have before observed, I do not see where the modern Hindoos could have found the knowledge necessary for the purpose of computing those tables backward, from a given set of modern observations. It is but of late days, that the Europeans have possessed any data for calculating the disturbances in the planetary motions arising from their mutual action and reaction.

If the Hindoos have it, then must that knowledge be grounded on a series of exact and actual observations, which can hardly be referred to a date more modern than the æra contested. I have seen nothing furrther on this controversy, excepting a slight notice of it under the article astronomy, in the new Encyclopædia now publishing at Edinburgh under the direction of Dr. Brewster; in which the compiler of that article, is by no means satisfied with the reasoning of Mr. Bentley, but adheres to the opinions of Bailly and Playfair.

For my own part, I see nothing that a christian has to object to the antiquity and reality of the Hindoo observations, at or near to the æra of the Kaly-Youg. I adopt for reasons presently to be given, the chronology of the Sep-

P

tuagint version. According to the modern English chronologers who follow the Hebrew text and Archbishop Usher, 4004 Years elapsed from the creation to the birth of Christ. Taking the chronology of the seventy, that interval consisted of 5872 years; according to the Samaritan, of 4700. On which of these conflicting systems, has orthodoxy stampt the impression of infallibility? Suppose we adopt the Septuagint translation, which I have no doubt of shewing to be the most worthy of acceptation: then deduct 3102 from 5872, and it will allow 2770 years for the world to acquire the requisite knowledge of astronomy to compose astronomical tables such as the Hindoo, at the commencement of the æra of Kaly-Youg! And where is the extravagance or improbability of this supposition? It has hardly taken a fourth part of that time in Europe.

NOTE 3. The effect of labour-saving machinery in augmenting the actual military force of Great Britain, so as to bring it nearly on a par even with Buonaparte's enormous establisment, is so well stated in the Quarterly Review of captain Pasley's Essay on the military Policy and Institutions of Great Britain; No. 10 May 1811, p. 406. that I am tempted to copy the passage. The subject appears to me very important, and the reasoning conclusive.

" The population opposed to us in our contest with " the Emperor of the French, Captain Pasley intimates " as five to one: and numerically speaking he is perhaps " sufficiently accurate. But the power of producing " and maintaining armies, results so little from mere po- " pulation, that previous to the time of Francis 1st, it is " well known, no standing army was or could be main- " tained in Europe; and from that time, armies have " only encreased with encreased civilization. The cause " of this is not obscure. Millions of persons may subsist " in a rude state, and consume the produce of the soil " without acquiring a particle of that kind of power, " which contributes to the maintainance of an army, or " to any other national object. In the feudal times, im- " perfect agriculture and the want of roads, scarcely per- " permitted the cultivators to dispose of a surplus suffi- " cient to furnish money contributions for the support " of the regal and baronial courts. The progress of civi- " lization, taught a more economical and effectual appli- " cation of human labour; and an increasing number of " persons could be fed, beside those who cultivated the " land. To procure their share, these superflous look- " ers-on, become manufacturers; whence arose in the " natural order of gradation, trade, money, and facility of

" taxation; and it is in reality from the degree in which " scientific skill, or skilful labour exists in a country, " that the permanent maintainance of armies is to be cal-" culated. In a ruder state of things, nothing can be " furnished beyond the raw material——untutored man.

" The real enquiry for our purpose therefore is, the " quantity of machinery, of scientific labour, and of the " means of employing both, existing in England, as " compared with the same resources in the dominions of " Buonaparte. A difference in our favour all will allow: " because if both had remained stationary since the " commencement of the war, our superiority was evi-" dent from the vent of our manufactured goods on the " continent, and that too in dispite of the higher price " paid in England for labour to each individual work-" man. And what has happened since the commence-" ment of the war? Except those ornamental manufac-" tures which are maintained not by profit, but at the " expence of the government from motives of vanity or " policy, all manufacture in France is extinct or nearly " so.* Over the rest of the continent, war has occasi-

* This alludes to the gobelin tapistry manufactory: to the plate glass manufactory: to the Seve and Angoulesme manufactory of Porcelain; and perhaps to the Lyons manufactory of silks and velvets.

"oned a desol tion unparalleled since the irruption of the "Barbarians; and war-contributions have annihilated "the visible capital of the manufacturer, and therewith "of course all his exertions. This we may conclude "without fear of error, from the otherwise unaccounta- "ble and incredible avidity with which English goods "are purchased even in increased quantities, though at "a price proportioned to the danger of hazarding the "vengeance of the laws, (if they may be so called) "which have been made for their exclusion.

"The prosperous application of large capital we have "daily opportunity of seeing. In one place a large steam- "engine performs the manual labour of five hundred "able men; in another place a cotton-mill works with "all the delicacy of five hundred skilful artizans; and a "thousand men may be thus marched to the army with- "out national loss. In machinery less striking than "these popular instances, no less progress is made. For "instance, agricultural instruments employed about a "hundred and twenty persons, masters and workmen "in London, twenty years ago: now, upwards of two "thousand are engaged in this manufacture:* but this

* Principally in threshing machines, chaff cutting machines, winnowing machines, machines for bruising grain and trenching ploughs.

" encrease in their number is accompanied by the dis-
" charge of thousands and tens of thousands from ma-
" nual labour; and so proportionably has machinery
" lent aid to all other trades and callings. Co-operating
" with machinery in advancing our power, is obviously
" the division of labour: the effect of which, having
" been so ably examined and stated to have become an
" indisputed principle, has only been mentioned in this
" place, lest we should seem to forget that it has conspi-
" cuously encreased in the last ten years.

" Another source of national power, though not un-
" known, and even fairly, recognized by all when men-
" tioned is not so highly appreciated as it deserves. We
" allude to the striking increase of task-work, which
" operates directly on the individual so employed, caus-
" ing him usually to produce twice as much work as be-
" fore, and with twice as much complacency, as when he
" toils listlessly for daily wages: the effect on him being
" in the one case to make him do as much, and in the
" other as little as possible. The *indirect* effect of task-
" work, is on the day-labourers, who are not permitted
" to lag far behind the task-workers, when a comparison
" is at hand. An appeal to the several classes of socie-
" ty, would produce their testimony that Task-work has

" increased and is increasing in almost every species of " labour to which it is applicable: but the most im- " portant example of this, is in agriculture, which must " always remain the most general occupation in England. " In short, it would not be too much to affirm, that the " habit of Task-work has augmented fourfold within the " last twenty years, and doubled within the last seven " years.

" It is obvious, that we have only to continue the means " of doing by machinery the work of men, and we may " maintain the men in the service of the public—to " divide labour, and to extend the fashion of Task-work, " by which few do the work of many, and we may take " the overplus into our navy and army. We have " already done this to the amount of half a million of " men, of whom 400,000 have been added to the mili- " tary establishment since the Commencement of the " war.

" The following statement of our effective forces " (including officers) at the close of last year (1810) will " be at once satisfactory to our readers, and useful to our " argument. Our regular cavalry appears from authen- " tic returns, to have been on the 25th December last " 31,375. Our regular infantry including the foreign

" and colonial corps, 211,574. The artillery, horse " and foot, 22,346, making in all of regular land force, " 265,295 men.

" The vote for Seamen and marines was in 1810 " increased to 145,000,and it was stated in parliament that " this increased vote was necessary, because that number " were actually in service. The regular militias of the " Empire amounted to 95,440 ; and thus we have a total " of actual military and naval force of upwards of 500,000 " men—a force more than double, the military establish- " ment of the Roman Empire under Augustus. * *

" The local militia of Great Britain which assembled " for exercise at the last inspection, amounted to 167,000. " The Volunteers in Great Britain are 52,000 Infantry " and 18000 Cavalry. In Ireland 67,000 Infantry, 8000 " Cavalry : a total irregular force of 312,000. Thus " in the whole we offer to the world the proud and " commanding spectacle of 820,000 men in arms."

It was truly said in debate by lord Loughborough, that when weighed in the balance of national utility with such men as Sir R. Arkwright, the Duke of Bridgwater Watt, Bolton, and Wedgewood, the Lords and the Commons would kick the Beam.

The first stept in this country (America) toward such a labour-saving system, by which men may be spared, not for depopulating contests, but for populating our deserts—must begin as in the old country, with the universal encouragement of Roads, Rail-ways and Canals; the general introduction for land Carriage, of one and two horse carts; the absolute prohibition of heavy loads upon narrow wheels as in the 5th Sect. of the English turnpike act; and of teams beyond four horses: without these regulations, no turnpikes in this country can pay common interest; the system will decline, and all hope of good roads must be abandoned. In England this is well understood; tho' not yet fully, and every where acted upon; but every day produces conviction of the necessity both theoretical and practical, of adopting these improvements.

Rail-Roads, are of so much national importance, and so little known among us, that I do not think it necessary to apologize for stepping a little out of the road, to give some account of them. I extract the following facts from a paper in 38 Phil. Mag. 51.

Rail-ways, are roads of easy inclination, having cast iron rails on which waggons with wheels adapted to those rails, move. The rails are usually three feet long, and each end rests on stone, wood, or cast iron, firmly bedded. They are four or five inches broad, with a small circular rise in the middle, which fits the hollow of the cast wheel, and keeps it steady; so that the wheel in fact moves upon two edges. In my time, all the rail ways about Newcastle for the use of the Collieries, were of wood; and so they were in all the coal mines. The rail ways about the iron works of Colebrook-dale, laid by the proprietors for the use of the works only, were of iron, and would extend (taken together) between 40 and 50 miles.

Rail ways were first laid for the use of the Collieries at Newcastle in 1680. In 1738 they were introduced at the Whitehaven works: they were of wood; iron was tried; but the great weights upon a single waggon, proved too much. In 1768 the weight drawn by one horse was divided among 3 or 4 small waggons, instead of one large one. This enabled the cast iron rail ways, to answer. In 1794 they began to be constructed as branches to canals, and from that time to this, they have been exended in every direction in England.

The levels of the canals with which that country is now every were intersected, frequently call for inclined planes. These are iron rail ways. A perpetual chain, raises and lowers the waggons, which disengage themselves by a contrivance at each extremity of the plane.

In some cases, machinery moved by water or by steam is employed. At Chapel le frith in Lancashire, the inclined plane is 550 yards long. The proposed rail-way between Berwick upon Tweed, and Glasgow in Scotland, will require several, as the summit of the rail-way is 753 feet above the level of the Berwick quay: but these are no obstacles to that most ingenious people, whose characteristic is, boldness of design in all works of utility, put in execution by well-considered, patiently-persevering industry. Great weights have been moved for short distances upon rail ways; but the following are taken from actual daily practice.

With $1\frac{1}{5}$ inch declivity per yard, one horse draws downwards three waggons each containing two Tons. On a rise of 1 2 inch per yard, one horse takes two Tons upwards.

With eight feet rise in 66 yards or nearly $1\frac{1}{4}$ inch per yard, one horse takes two Tons upwards. On the Penryhn rail way $1\frac{1}{4}$ inch per yard, two horses draw downwards 4 waggons each containing one ton of Slate. With a slope of 55 feet per mile, one horse takes from 12 to 15 tons downwards, and 4 tons upwards, and all the empty waggons (3 Rep. Arts 2nd series). At Ayr in Scotland, one horse draws on a level five waggons each containing one ton of coal.

On the Surry rail road, which is 26 miles long, one horse on a declivity of one inch in 10 feet, draws 50 quarters of wheat. (Malcolm's agricultural report of Surry).

Hence it may be considered, that on a slope of 10 feet to a mile, one horse may be appointed to draw five tons upwards, and seven tons downward.

The same review of Capt. Pasley's work, contains an able disquisition on the very superior importance of internal, over external Commerce, even to such a country as Great Britain; a proposition, which I was considered as paradoxical for maintaining at some length in the year 1800. Mr. Spence's pamphlet a year or two ago on the same subject, goes far also to shew that even Great Britain may be "Independent of Commerce." I regard her external trade as an engine of defence, not of wealth.

NOTE 4. I adopt the Septuagint Version, in preference either to the Hebrew or Samaritan text, or Samaritan Version.

1st. Because without adopting the fabulous account of Aristæus, and his Seventy two interpreters, it appears to me likely, that the most authentic copy of the Jewish Scriptures, would have been furnished or sought out for the purpose of that Version: whether undertaken at royal instigation, or by private persons from private motives. It would naturally be the interest, equally of the Jewish nation, and of the learned men of the day, that this should be the case. Neither does there seem to be any adequate assignable reason, why genealogical or chronological mutilations or interpolations, should take place: nor could any alteration of the received chronology have passed without observation, under the circumstances of a version that must have attracted much notice at the time.

2dly. Some slight variations have crept into the copies even of the Septuagint. Thus according to Eusebius and the Septuagint, the interval from the Creation to the flood, is 2242 years: according to Josephus and the Septuagint 2256 years: according to Julius Africanus, Epiphanius and the Septuagint 2262 years: but these are so slight, as to corroborate the general authenticity of the version.

3dly. The quotations out of the Old Testament made not only by Jesus Christ and his Apostles, but by the more ancient fathers also, are allowed to be from the Septuagint version or its original, being in many places conformable to this copy, and differing from the Hebrew text. I refer generally for proofs of this, to Pezron's

Antiquitè de Tems retablíe, and the second Chapter of Carpzovius page 526 et seqq. 4thly It is notorious that the christians of the three first centuries universally counted 5500 years from the creation to the birth of Christ. This is distinctly admitted by Jos. Scaliger in his Prolegomena in Chron. Eusebii. 5thly. The best qualified among the moderns as well as among the ancients, to judge of this question, have; preferred the Samaritan version. Was not Josephus capable of adopting the most authentic chronology of his own country, himself a Jew? Walton in his prolegomena, Is. Vossius in his Chronologia sacra, Pezron, and tho' last not least, Dr. Kennicot, may be mentioned as approving by preference of this version. Dr. Kennicot has laid the christian world under great obligations, by his most elaborate edition of the Hebrew Bible with various readings, printed at Oxford under the patronage of George the third. A work that occupied the learned editor upwards of twenty years. 6thly. I confess myself prejudiced in favour of that copy, which harmonizes most easily, with authenticated facts of profane history.

I do not know that any point of faith, depends upon disputed points of chronology: and if such were the case, it is impossible to harmonize the Hebrew text and

Samaritan version, in this respect, either with each other, or with the Septuagint version. Besides, there is more latitude for mistake, and for error of copyists, in the numeral passages, than in any other. Hence in law proceedings, the English practice, properly requires that dates should be in words at length. Nor is it possible to reconcile Manetho or Josephus with any text extant; or Pezron with Petau; or Newton, Whiston, Marsham, Bedford, the Bishop of Clogher, and Usher with each other. I have formerly tried this, but in vain. Hence it seems to me, conducive to the fair and reasonable interest of christianity, to lean to that edition of the scriptures, which best accords with facts established on defensible grounds, and that affords the least occasion, either for the plausible objections, or unreasonable cavils, of those who do not acknowledge the divine authority of the scripture books. The authorities and arguments o the chief points involved in the controversy respecting the Septuagint version, are learnedly and laboriously collected by J. G. Carpzovius in his Critica Sacra, quto Leipsig 1728, which is in this college. The summary of the same kind, contained in Strauchius's Brev. Chronolog. translated by Sault (p. 166—176) is not here:

I have dwelt the longer on the Hindoo tables and the Septuagint Chronology, because I do not recollect any former attempt to reconcile accounts supposed to be at variance, but which certainly do not hold out a dissonance so formidable, as we have usually supposed.

NOTE 5. *Tubal Cain.* M. de la Vaur, in his Conference de la fable avec l'histoire Sainte, founds the supposition on some fanciful Hebrew etymologiesas well as on similarity of name, occupation, and tradition.

4 Gen. 22. I have suggested that I do not consider the word BRASS (necosheth) a correct translation It is spoken of in the following passages of the Old Testament, which I have collected with the assistance of Cruden. The 25th, 26th, 27th, 30th, 31st, 35th, 36th, 38th and 39th, chapters of Exodus in many places. 21 Numb. 9. 31 Numb. 22. 8 Deut. 9. 28 Deut. 23. 33 Deut. 25. 22 Josh. 8. 16 Judges 21. 1 Sam. c. 17. v. 5, 6, 38. 2 Sam. c. 8. v. 8. 1 Chron. 18. v. 8. and 22. v. 14, 16. 2 Chron. 2. v. 7. and 24. v. 12. and 4 v. 16. and in about fifty more places. But in none of these passages is there any intimation that it is an ALLOY. 31 Numbers 22. "Brass and iron which may abide the fire." Now Brass will not abide the fire; at least not a considerable heat. 28 Job 2. "Iron is taken out of the

earth, and brass is molten out of the stone:" but it is not so.

Again, brass is never found native; it is the produce of art. Copper is a very common and plentiful metal even in a native state. Copper is no where mentioned in the Old Testament but in 8 Ezra 27. "Two vessels of fine copper precious as gold." No mention is made in Scripture of zinc or any of its ores. Hence I conclude, by brass, is meant copper in all these passages.

With respect to *the other metals*, the principal pasare these

13 Gen. 2. "Abram was very rich in silver and gold." Gold has four names in the Bible: 1st, *Segor*, from Sagar, shut up, viz. in the earth. 2dly, *Kethem*, from Catham to stamp, to seal. 3dly, *Zahab*, wrought or beaten gold. 4thly, *Paz*, solid melted gold.

23 Gen. 15. "Four hundred shekels of silver."

24 Gen. 22. "A golden ear ring and two bracelets."

44 Gen. 2. "Put my silver cup in the sack's mouth."

28 Job 1, 2. "Surely there is a vein for the silver, and a place for the gold where they fine it. Iron is taken out of the earth, and brass is molten out of the stone."

25 Prov. 4 and 26 Prov. 23. Mention is made of silver dross, which seems to indicate some knowledge of

refining with lead or tin. See also 12 Ps. 6. and 66 Ps. 10. 17 Prov. 3. 1 Is. 22. 22 Ezek. 18. and 3 Malachi 3.

In 31 Numb. 22 mention is made of gold, silver, brass (that is copper) iron, tin, and lead: an enumeration that seems to comprize all the metals then known. 10 Jer. 9. "Silver spread into plates is brought from Tarshish." In like manner tin and lead were brought from the same place. 27 Ez. 12. Tin is also mentioned in 31 Numb. 22. 1 Is. 25. 22 Ezek. 18, 20. The antients in Pliny's day refined gold by tin and lead. 38 Plin. 19. Suidas v. 1. p. 765.

Lead is mentioned, but with no remarkable indication in 15 Exod. 10. 31 Numb. 22. 19 Job. 24. 6 Jer. 29. 22 Ez. 18, 20. 27 Ex. 12. 5 Zech. 7, 8.

Gilding seems to have been known in the time of Moses. 39 Exod. 3. they did beat Gold (zahab) into thin plates." The process of making the golden calf drinkable, is noticed further on, in the text of the Lecture. 28 Job. 17. will bear an interpretation of gilt chrystal; but whether this be glass, I greatly doubt.

There is no doubt however but the metals, particularly the precious metals, were more abundant in the early ages of the world than now, and easier to be obtained from the earth : in progress of time, they have been used up. The native metals would be sedulously sought for, and these would gradually introduce the knowledge of ores and of smelting. Gold, silver, copper, and iron, are still found native in abundance. But the use of this last metal, was certainly much confined. It does not appear from any express passage, that iron was employed in the building of the Tabernacle.

NOTE 6. *Wine.* 9 Gen. 20. And Noah began to be a husbandman and planted a vineyard, and he drank of the wine, and was drunken. 14 Gen. 18. Melchisedeck brought out wine. 40 Gen. 9. And behold a vine was before me. 9 Judges 12. And the vine said unto the trees, should I leave my wine which cheereth God and man? that is the high and the low. The word God is often used in Scripture as a term of the superlative degree, as mountains of God, for high mountains; rivers of God, for great rivers, so for princes and great men; thus 4 Exod. 16. Thou shalt be to Aaron instead of a God. 7 Exod. 1. I have made thee a God to Pharaoh. 22 Exod. 28. Thou shalt not revile the Gods, nor curse the rulers of thy people. 82 Ps. 1. God judgeth among the Gods. Ib. v. 6. I have said ye are Gods.

I cannot find mention in Scripture of any other than

Red wine. 75 Psalm. 8. 23 Prov. 31. 27 Is. 2. 63 Is. 3, 4.

As to the *mode of manufacturing* it. 24 Job 11. "Which make oil within their walls, and tread their wine presses, and suffer thirst." 63 Is. 3, 4. "Wherefore art thou red in thine apparel, and thy garments like him that treadeth in the wine-fat?" Hence, presses by machinery were not then used, but the juice was trodden out by men's feet; notwithstanding 24 Job 11. which looks to the contrary. The management of the fermentation seems to be alluded to in 32 Job 19. "Behold, my belly is as wine which hath no vent, it is ready to burst like new bottles." It appears from 27 Exod. 18. that the wine of Helbon a place in Syria was much esteemed. The Egyptians attributed the invention of wine to Osiris, the Dionusus or Bacchus of the Greeks.

Dr. Darwin, who had drank port till he was forty years of age and became gouty, became also a most violent enemy to every kind of fermented liquor. With all the fancy of a poet, (for I think the idea is his own) he imagines that the story of Prometheus who stole fire from heaven, and was condemned to the punishment of having a vulture perpetually feeding upon his liver, was intended by the ancients as an allegorical condemnation of the use of strong liquors, which no doubt have a peculiar tendency to bring on hepatic complaints. But unless the strong drink given by Ulysses to Polyphemus, which existed only in Homer's imagination, I know of no liquor among the ancients stronger than common wine.

That the gout and the stone, (symptoms and alternations of the same general disorder) are both owing to the *fluids* of the body being made acid by acid drinks, or secreted acid in consequence of dyspepsy, or hereditary morbid action in the stomach and secreting vessels, I have no doubt whatever. Hence the cases of stone among young people, and the gout among old people in the wine countries of France, and the cyder countries of England. Hence the gout among men who verge to the decline of life, and live freely. All wine, even the best Madeira (the Falernum of the moderns) is vinegar. Take a slip of Litmus paper; dip it in vinegar, it will turn red. Dip another slip in wine, it will turn red also, and nearly equally so. The experiments of Dr. Egan of Dublin, shew that the uric acid is percipitated in the temperature of 96 by almost all the other acids; and all the acids taken into the body are liable to be converted into uric acid. The experiments of Scheele, shew that the acid of the stone is the lithic or uric acid. The experiments of Dr. Wollaston shew, that the chalk stone is urate of soda, and urate of lime. The experiments of Mr. Brande shew, that magnesia is almost a specific for gout and for stone.

Formerly, all disorders were ascribed to the state of the fluids; then the fluids became as nothing in the Pathological theories of the German and Scotch schools; all was attributed to the morbid state of the solids; but as the solids are formed out of the fluids, the humoural pathology cannot be totally rejected. The first person mentioned as afflicted with the gout, was Asa king of Judah. 1 Kings c. 15. v. 23. 2 Chron. c. 16. v. 12.

Mr. Brande has lately acertained that Marcella wine contains 26 per cent of Alcohol; red campaigne 20; port 20 to 24; madeira 19; claret 15; cyder and perry 12; ale 9; brown stout 8; Porter 6.

NOTE 7. *Embalming* 50 Gen. 2. Joseph commanded the Physicians to embalm his father. And forty days were fulfilled for him; for so are fulfilled the days of those that are embalming. And the Egyptians mourned for him threescore and ten days. The process of embalming is thus given by Herodotus (Euterpe 86. et seq.) Take out the brains and bowels. Wash the body: let it lie seventy days in nitre: fill it with myrrh, cassia and spices: then bandage it in cotton dipt in a solution of gum acacia, (which is similar to our gum arabic.) Their nitre probably was soda, mixed with calcareous and cubic nitre. The intestines were laid open with an Ethiopian stone; doubtless Obsidian. Diodorus Siculus, like Herodotus, describes three methods of embalming. For an examination of a mumony see Phil. Trans. for 1764. The cloth hitherto found enveloping mummies, is very coarse.

NOTE 8. The *sacred oil* and ointment is described in 30 Exod. 34, 35. &c. and probably alluded to also in 1. Chron. ix. 30.

Olive oil: 27 Exod. 10. 30 Exod. 24. 24 Lev. 2. 8 Deut. 8. 2 Kings xviii. 32.

They pounded the olives in mortars, 27 Exod. 10.

Oil is noticed as being used for lamps 25 Exod. 6, 31. This use of oil was not known in Homer's time among the Greeks, for he describes the rooms as lighted by fires. 6 Odyss. v. 305. 18 Odyss. v. 306 19 Odyss v. 63. though they burnt torches. I think with the President Goguet (orig. of laws, arts and sciences, V. 2. p. 194 English edition.) that λυχνος means rather a chafing dish, or brazier, than a lamp, when used by Homer. Cecrops first introduced the olive tree into Greece from Sais in lower Egypt according to 2 Herod. 59. 62.

Note 9. and 10. *Pitch.* 6 Gen. 14. pitch it within and without. 2 Exod. 3. she daubed it with slime (bitumen or tar) and with pitch. 34 Is. 9. the streams thereof shall be turned to pitch.

Rosin is the residuum of the distillation of turpentine, for spirits, or the essential oil of turpentine, without water. Burgundy pitch, is the like residuum when water is employed.

Note 11. *Gems.* 28 Exod. 17. and thou shalt set in it settings of stones, even four rows of stone: The first row a sardius, a topaz, a carbuncle: the second row, an emerald a sapphire and a diamond: the third row a ligure, (unknown) an agate, and an amethyst: the fourth row, a beryl, an onyx and a jasper. They shall be set in gold in their enclosings. To the same purpose 39 Exod. 10—13. where these stones are also described as engraven with the twelve names of the twelve tribes of Israel. So also 28 Exod. 9. 39 Exod. 14. 34 Exod. 1.

Goguet ii. 115. renders it probable, that the diamond was not known at this time. Indeed, what these stones really were, can hardly be guessed at now.

The original names the precious stons, are

Sardius, *odem*, from adam, ruddy; a Ruby.

Topaz *pildah*, greenish with yellow; a Topaz, Chrysolite.

Carbuncle, *bareket*, from barak to glitter.

Emerald *nophec*.

Sapphire, *saphir*.

Diamond, *yahalom*, from halam, to strike upon: it was by this test, that large diamonds in great numbers were broken and destroyed, soon after the discovery of the Brazil diamond mines.

Ligure, *leshem*.

Agate, *shebo*, from shab, to change.

Amethyst, *achelamah*.

Beryl, *tarshish*.

Onyx, *shoham*.

Jasper, *yashpeh*, whence the modern name.

2 Gen. 12. mentions the land of Havilah as productive of precious stones. Many kinds are also noticed in 28 Job 6.

The art of cutting diamonds, was first discovered by Lewis de Berquen 1476. Emery will not scratch the diamond, otherwise there is reason to believe it was known very anciently 41 Job 15. (Septuagint translation) 5 Dioscorid. 166 Hesychyus voce σμυρις (Smuris.)

NOTE 12. I will put together here the principal passages contained in the Old Testament, relating to the art of *Dyeing*. The text in 25 Ex. 5. concerning the ramskins dyed red, is literally the skins of red rams; violet-coloured sheep are not unusual in the Levant. Such was the ram of Polyphemus 9 Odyss, 425.

37 Gen. 3. He made (for Joseph) a coat of many colours.

Blue, purple, *(argaman)* scarlet *(Tolaat sheni:* a worm or insect: probably, Kermes. The Septuagint and the vulgate, translate it Coccus. Coccus Ilicis celerrimè in vermiculum se mutans says Plin. L. 24. ch. 4.) and crimson, one or other or all, are noticed in the following passage. 25 Exod. 4. 26 Exod 1; 31, 36. 27 Exod. 16. 28 Exod. 31. 39 Exod. 3, 22, 24. 4 Numb. 8, 12, 13. 15 Numb. 38. 8 Judges 26. 2 Chron. 2. v. 7, 14. 2 Chron. 3. v. 14. 1 Esther 6. 8 Esther 15. 31 Prov. 22. 3 Cant. 10. 7 Cant. 5. 10 Jerem. 9. 23 Ezek. 6. 27 Ezek. 7, 16, 23. This last mentioned chapter of Ezekiel, contains a good summary of the commerce of the day, as to articles of luxury. There were three varieties of purple among the ancients, of which Pliny treats much at large. 9 Plin. 60. Herod. Eut. § 132.

NOTE 13. *Gilding*. See the passages cited, ante, (note 5.) in treating of the text which notices Tubal Cain. In particular 36 Exod. 34—36. 38 Exod. 17. 25 Exod. 11. 1 Kings vi. 20. 1 Chron. xxviii. 17. 2 Chron. iii, 4. ix. 17. In some passages a kind of plating with brass is mentioned, as 38 Exod. 6. He overlaid the staves of shittim wood with brass. 2 Chron. iv. 9. He over laid the doors of them with brass.

NOTE 14. The *Golden Calf*. Consummatissimum autem peritiæ alchemicæ specimen in comburendo et pulverando. Vitulo aureo, elucere credunt artis mystæ. Si totus aureus fuerit, eximium sine dubio heic delitescit artificium, nisi forte hepar sulphuris adhibuerit, cujus circiter sexdecem partes suscipirent unam auri, de in facilè in pulverem comminuendi, et aqua solvendi. Contendunt nonnulli, Vitulum fuisse ligneum auro obductum, et si ita, in hac operatione nullâ opus erat chemiâ. Bergman de primordiis chemiæ opuscula V. 4 editionis Lipsiensis. p. 66, 67. For this last opinion (that it was gilt wood) he refers to the illustrious Michaelis (Con. illustr. Michaelis) then I believe his Britannic Majesty's professor of divinity at Gottingen; whose Lectures on the New Testament are in high and deserved estimation not only in Great Britain but throughout Europe.

NOTE 15. *Butter* This is also made mention of in the following passages besides those cited in the Lecture. 5 Jud. 25. 2 Sam. xvii. 29. 20 Job 17. 29 Job 6. 55 Ps. 21. 30 Prov. 33. 7 Is. 15, 22.

NOTE 16. *Bread* Leavened Bread, 12 Ex. 15. 13 Ex. 3. 23 Ex. 18. 16 Deut. 3, 4. 7 Lev. 13. the same conclusion is to be drawn from the use of unleavened bread; for where this is specifically noticed, it implies the knowledge of raising the dough. 19 Gen. 3. 12 Exod. 8, 15. 13 Exod. 6, 7. 23 Exod. 15. and many passages in Leviticus, Numbers, Deuteronomy &c.—Barley appears to have been in use for cakes or unleavened bread. 7 Judges 13. 4 Ezek. 12. latterly however, the Jews appear to have learned the art of fermenting or leavening barley dough; for in the New Testament 6 John 9, 13. mention is made of barley loaves.

One of the great staples of Egypt was grain, and the bread of Alexandria was very white 18 Plin. 7. the general leaven was sour dough 18 Plin. 11. but from the following passage, I conjecture the Gauls and Spaniards made use of yeast. Galliæ et Hispaneæ frumento in potum resoluto * * * spuma ita concreta, pro frumento utuntur. I regard *frumento* as a false reading for *fermento.*

Their zea or maize, they did not grind between millstones but pounded in a mortar as we do now to make hommy 18 Plin. 11. Tunditur grana ea in Pilâ ligreâ.

Bread was also made from the Lotos or water Lilly. Herod. Eut. 92. they used also the Byblus for that purpose, or rather in lieu of bread. Ib.

NOTE 17. *Mills.* 11 Exod. 5. The maid servant that standeth behind the mill.

11 Numb. 8. the people ground The Manna in a mill.

4 Deut. 6. No man shall take the millstone as a pledge.

41 Job. 24. His heart is as hard as a piece of the nether millstone. See also 9 Judg. 53. 2 Sam. xi. 21.

These mills must have been hand mills, from the passage above cited 11 Exod. 4, 5. and probably were of the same kind and form, as the mills still used for the same purpose in Hindoostan, of which a plate is given in one of the numbers of Tilloch.

The Greeks like other ancient nations had nothing but hand mills, 1 Gog. 105.

NOTE 18. *Vinegar* as a beverage is noticed in 6 Numb. 3. A Nazarite shall drink no vinegar of wine. Quere if this implies any other kind of vinegar? 2 Ruth 14. Dip thy morsel in the vinegar. 69 Ps. 21. They gave me gall for my meat, and in my thirst they give me vinegar to drink. This implies, it was then a vulgar beverage. Hence perhaps the vinegar and water offered to Christ upon the cross. Cleopatra's pearl dissolved in vinegar is mentioned Plin. l. 9. c. 33. 8 Vitruv. c. 3.

Note 19. *Egypt* Cham. the son of Noah 78 Ps. 51. 104 Ps. 23, 27. 105 Ps. 23 27. 106 Ps. 22. Mizraim 13 Gen. 11. 41 Gen. 41. 45 Gen. 18 Mizraim is suspected to be either the Osiris or Menes of Egypt.

Note 20. *Hermes.* See the account of Albertus Magnus in 4 Berg. Opusc. De primordiis Chemiæ 44. &c.

The fragments of Manetho and Sanconiathan are collected by Bishop Cumberland. They are to be found in Julius Africanus, Eusebius, and Josephus.

Osiris is considered as preceeding Menes (probable the Menu of the Hindoos) who reigned or began to reign 2094 years after the Creation according to Pezron's calculation (p. 325.) see 1 Gog. 108.

Note 21. *Glass.* That nitrum means an alkaline salt, and sometimes the vegetable alkali, is evident from the following passages.

Ex quercu cremata, fieri nitrum—Cremati roboris cinerem, nitrosum esse certum est 17 Pl. 8. 31 Pl. 7. and the same may be collected from two or three passages in 36 Pl. 26. wherein he discribes, the substances and the process employed in the manufacture of glass.

Natron was procured also at the Greek colony of Naucrate. Strabo mentions two nitre pits beyond Memphis. 31 Plin. 10 says, that to procure SALT, they let the sea into their pits: to procure NITRE, the water of the Nile: but I do not understand him to mean, that the nitre was procured simply by the evaporation of the Nile, which I apprehend was used only for lixiviation. Salinis, mare infundunt; Nilum autem nitrariis. Excedente Nilo, siccantur; decedente madent succo nitri 40 diebus continuis. I have no doubt this was, a very impure commixture of salts. It was useful he says for glass; hence it contained an alkali, for the nitre might be decomposed by the carbonaceous impurites. It was used by the dyers and printers (ad inficiandas et tincturas omnes) hence it contained also alum. It was adulterated with lime, which extricated a pungent odour; hence it was contaminated with salammoniac, or nitrat of ammonia. This arose from the many putrefying animal substances in that warm country. It is thus that the azot is furnished in all artificial nitre beds. In the natural nitre beds of Spain, the east Indies, and the caves of our western country, it is furnished in consequence of their being for ages frequented by animals, whose urine decomposed furnishes nitrogen—the air, oxygen—and the rock, calcareous earth. See further as to the natron of the ancients, the note of Bergman de prim. Chem. Sect. 3 parag. D. wherein he mentions the experiments of Boyle and Barkhusen to prove the alkaline nature of ancient nitrum or natron.

The following passages in Pliny respecting *glass*, will give rise to some curious chemical reflections. Mox ut est astuta et ingeniosa solertia, non fuit contentum vitrum miscuisse. Cœptus et addi magnes lapis, quoniam in se liquorem vitri quoque ut ferrum trahere creditur. lib. xxxvi. 36. Lapis hic magnes, et in Cantabriâ nascitur; non ille magnes verus caute continuâ, sed sparsâ bubbatione, ita appellant: nescio *an vitro fundendo* perindè utilis; nondum etiam expertus est quisquam. lib. xxxiv. 14. These expressions distinctly relate in the first instance to the property of the magnet of attracting iron, well known to the ancients. But they evidently also relate to the well known property of manganese, in depriving glass of its colour, and clearing it. Manganese is very frequently found with iron, and might easily be taken for an iron ore.

Colossal Serapis, (Lecture page 19,) mentioned by Pliny. The passage is in Plin. xxvii, 5.

Cyanus. (Lecture ib.) see Theoph. de lapidibus 98.

The passage in Pliny relating to *coloured gems and glass* is curious xxxvi. 26. Fit et tincturæ genere obsidianum ad escaria vasa, et totum rubens vitrum, atque non translucens Hematinon appellatum. Fit et album et myrrhinum, aut hyacinthos sapphirosque imitatum et omnibus aliis coloribus. Maximus tamen honos in candido translucentibus quam proxima crystalli similitudine. Usus verò ad potandum argenti metalla et auri pepulit. For more of the myrrhina, see Plin. xxxvii 2.

The cups sold to Nero. Perhaps I am wrong in saying they were *sold* to Nero. The original is, sed quid refert Neronis principatu repertâ vitri arte, quæ modicos calices duos, quos appellabant Pterotos, H——S sex millibus venderet. 36 Plin 26. Millies H——S is £807,291 : 13 : 4. Sterling, according to Arbuthnot.

The Obelisk in the temple of Jupiter noticed by Theophrastus, is mentioned also 37 Plin. 5.

The Emerald Column (Lecture p. 20.) at the Temple of Hercules at Tyre, is mentioned by Herodotus in Euterpe 44. There is much learning on the subject of ancient emeralds in 2 Goguet 122 at seqq. which I chuse to refer to, rather than borrow, or tread exactly the same ground. Herodotus in his third book (Thalia) mentions glass υελος, as being dug out of the earth; and therefore, it is evidently confounded either with transparent quartz chrystal, found in the mountains of Ethiopia, or with foliated Gypsum, or with transparent plates of Mica: for I do not agree with Gesner that the passage means Amber. The term γυψωσαντες, terra coctâ induentes, may possibly mean, enveloping the body in burnt gypsum or sulphat of lime; Pliny's description of gypsum applies beyond doubt to the modern stone so called. See 36 Pli. 24.

It is evident to me that Lapis Specularis, was used not only for the large plates of Mica that we call Muscovy Talc, but also for the foliated Gypsum: generally however for Mica; as I collect from the following passages.

The Roman apartments were sheltered from the sun, some times by Curtains, *Vela;* from the cold, by windows, *Specularia.* Hence Specularius a glazier Ulpian, l. quæsitum 12. The specula however, were polished metalline mirrors: compare Phædr. 3. 8. 4. with Terence 3. 3. 61. Of the Lapis Specularis, they made transparent Beehives, 21 Pl. 47. and Hot-houses; an article of family comfort, as well as elegant luxury, almost as yet, unknown in America; not much to the credit of our taste, in any sense of the word.

Pallida me Cilicum timeant Pomaria brumam
Mordeat et tenerum fortior aura nemus,
Hibernis objecta notis SPECULAIRA puros,
Admittunt soles, et sinè fæce diem. &c.

8 Mart. 14.

Qui Corcyræi vidit pomaria Regis
Rus, Entelle, tuæ preferat ille Domus.
Invida purpureos urat ne bruma racemos,
Et gelidum Bacchi munera frigus edat;
Condita perspicuâ vivit vindemia gemmâ
Et tegitur, felix nec tamen uva latet.
Femineum lucet sic per bombycina corpus;
Calculus in nitidâ sic numeratur aquâ.
Quid non ingenio voluit natura licere?
Autumnum sterilis ferre jubetur hiems.

8 Mart. 68.

So Tiberius raised cucumbers in a hot house 19 Plin, 23. They heated them, as they heated the floors of their apartments, and their steam baths or sudatories, by flues. Sir Joseph Banks, on the hot-houses of the ancients. 30 Nich. Jour. 147.

Mr. Sansom, of Philadelphia in his letters from Italy p. 218 describing the present state of Pompeii, says "The windows were mostly closed with wooden shut-

"ters; yet some few of them had glass in them, which "was not perfectly transparent; and others were sashed "with Isinglass split into thin plates." (Lapis specularis, Mica.)

In the principal cities of France, England, and America, whose inhabitants are proud of the profusion in which the comforts and conveniences of life can be procured, hardly a house is furnished with a bath or a sudatory. At ancient Rome, and from Mr. Sansom's account at Pompeii, the bath-house with its boiler, flues, and funnels, was a regular part of the domestic establishment; as it is in the principal cities of Arabia, of Asia, and even of Africa.

The public baths at Philadelphia, are very trifling; frequented chiefly by foreigners, and by no means furnished with attendance and conveniences, necessary to the full enjoyment of this most salutary luxury: a luxury, which the Boors of Russia known how to enjoy, while in this country of boasted refinement, it is almost unknown.

The Lapis Specularis, began to be superceded by glass for windows, about the close of the third century: for St. Jerom (in Hes. xli. 16.) mentions them. So does Lactantius de Opific. Dei c. 8. Berg. de prim. Chem.

The coloured glass windows mentioned by Gregory of Tours, seem to belong rather to the middle age.

Glass figures throughout a solid piece (Lecture page 21.) Klaproth's account of this very curious specimen of antient art, will be found in 8 Nich. Jour. 225, 247.

Glass coloured by copper (Lecture p. 21.) *Grenaille*, is the Chinese preparation of copper for red glass. Water is gradually sprinkled on copper in fusion, which by this means is calcined, and used for the purpose mentioned. Perhaps this might suggest the experiments of Morveau and le Sage, which however have not yet reached this country.

Egyptian mummies (Lect. p. 23.) There is one in the British museum with colours extremely vivid, apparently mixed up with calcareous earth: but over all, is a varnish, which will bear washing with water. Still I do not think this amounts even to the probability of its being an oil varnish. Though I do not deny, that they might dissolve some of the common resins in liquid turpentine.

Sacro Catino or supposed Emerald Basin, taken from the Genoese by Buonaparte (Lecture page 23.) Morveau's examination and critique on it, will be found in 18 Nicholson's Journal 97.

Winkelman: (p. 24 of the Lecture) I have inadvertently mentioned this piece of art among the specimens of ancient glass, but it is a mosaic work still extant, but whether composed of pieces of coloured marble or coloured glass I know not. Winkelman, whom I quote at second hand from Dutens, having only the two first volumes of his history of art Paris ed. (Dutens quotes the German) mentions that in his day it was at Rome. Dutens says it belonged to Cardinal Furieti. Mr. Sansom of Philadelphia, in his American letters, mentions it as being still at Rome; but says that it is inferior to many specimens by modern artists. The description in Pliny is, Mirabilis ibi Columba bibens, et aquam umbrâ capitis infuscans; abripiente aliâ escam, ludentes videres in canthari labro. Apricantur alii scabentes se. There are four doves, in this piece. See also Sueton in Jul. Cæs. 46. Sansom's Amer. letters V. 1. p. 394.

Burning Glass. I quote the Orphic Verses from Bergman, for I have not the book: the passage is referred to by Dutens: Orphæi Opera Lipsii 1764 octavo p. 307 and sect. 275.

Chrystallum splendentem ac pellucidum accipe manibus,

Lapidem radium lucidi divini splendoris
Quo in æthere maximè delectatur decorum immortalium cor.
Quem si in manibus gestans ad fanum accesseris
Nullus deorum vota tua renuet.
Audi igitur ut discas vires splendentis lapidis;
Quod si placet absque vivaci igne flammas excitare,
Jubes aridas eum super faces deponere;
Tum verò ille sole ab oppositâ parte irradiante
Statim supra faces exiguum radium explicabit
Qui, quamprimùm siccam et pinguem attigerit materiem
Fumum, deinde ignem exiguum, denique verò flammam magnam
Excitabit: quem dicunt esse antiqui matris sacrum ignem
Non alia magis flamma spero ego
Immortalibus tam grata sacrificia urere.

The passage of Aristophanes is in his CLOUDS act. 2. sc. 1. v. 140. "Glass, by means whereof they kindle fire." And Strepsiades tells Socrates, he can thus burn up his bonds. See also Plut. in Numa.

The following passages are to the same purpose.

Cum additâ aquâ vitreæ pilæ sole adverso, in tantum excandescunt ut vestes exurant. 36 Plin. 26.

Invenio medicos quæ sunt urenda corporum; non aliter utilius id fieri putare quam crystallina pila adversis posita solis radiis. 37 Plin. To the same effect Lactant. de Irâ Dei ch. 10. and Clem. Alexand. Strom. lib. 6. The emperor Adrian writes from Alexandria to the Consul Servianus, that he had sent him some cups called *Alassontes* of party-coloured glass, which had been given to him by a priest there, and which he wished to appropriate to his sister and Servianus that they might use them on Hollidays. E libr. Phlegontis, Berg. p. 31. For more respecting the knowledge of the ancients on the subject of glass, see the Collection of antiquities by Comte Caylus; Winkelmans Historie de l' art chez les anciens. Dr. Falconer's (of Bath) memoir on the Knowledge of the ancients respecting glass in the second vol. of the Manchester transactions, and the authors already referred to.

Note 22. *Egyptians and Hindoos.* I cannot help thinking that the knowledge of the Egyptians was of Hindoo origin, because notwithstanding the considerations deducible from the ancient and modern latitude of Syene or Es-Saoun, and the Zodiacs of Tentyra, and Esne, which seem to carry the astronomical chronology of Egypt nearly as high as that of Hindostan, there is no evidence that the Hindoos derived any thing from Egypt, and there is evidence enough that the Egyptians introduced Hindoo customs and arts. The following circumstances render this opinion probable to me.

1st. Both nations were divided into casts: the Hindoos into four: for Diod. Siculus (who seems to have counted as a cast, the Parias or Chandalas, as well as the division into Visknou-Bukht, and Siva-Bukht) is mistaken in attributing seven to them, tho' the Egyptians appear to have had that number. In both countries the priesthood was of the highest class. 2ndly. Their astronomy in theory and practice appears to have been the same, but pursued with much more knowledge in ancient India. Their pole, their gnomon, the same division of the zodiac, of the day &c. 3dly. Their mythology is very similar. Isis and Osiris, answer to the Iswara and Baghera, the third personification of Vishnoo. Osiris, Bagis, Baghera Siva, answer to the Dionusus or Bacchus of the Greeks, who imported him from Egypt. This is manifest from the tradition of his having conquered India, from the emblem of the Phallus exhibited at his festivals, in all these countries; from the dedication of the Bull to him; from the consecration of the Egg at his orgies, &c. &c. So also, Isis the wife of Osiris, is Jas, the wife of Iswara. 4thly. Their hatred of the shepherd race and of the Jews, seems connected with the Indian prejudice against animal food. I know the Egyptians did not entirely abstain from this kind of eating, but they had a great number of sacred animals which it was unlawful to eat. Thus the Bull was equally sacred in Egypt and Hindostan. As to "the flesh pots of Egypt," this does not imply an extension of the custom beyond the land of Goshen, for the Israelites or Hebrews, were permitted to indulge in their usual food in the district allotted them; but then like other nations who devoured animals held sacred in Egypt, they were an abomination to the Egyptians. See Herod. Euter. 36. and 43 Gen. 32. 5thly. The doctrine of the metempsychosis, and of the immortality of the soul was common both to the Hindoos and Egyptians. The opinion of the immortality of the soul, was not prevalent among the Jews till after the Assyrian captivity, if known at all till then. The Indian Magi, according to Pausanias were the first who taught it. Indeed so late as the time of the apostle Paul, the Jews were divided on the subject. I have perused with great care Dr. Priestley's very ingenious argument in favour of the doctrine of a future state being known to, and embraced by the Jews under the Theocracy, but I do not see how to get over the considerations advanced by Dr. Warburton in his divine legation of Moses. 6thly. The Gymnosophists of Ethiopia, according to Philostratus, were a colony of Bramins who fled from the banks of the Ganges, on account of having murdered their monarch: it is likely therefore that there was an ancient communication between Ethiopia and the nearer parts of Hindostan, and we know the Egyptians were indebted for much knowledge to Ethiopia. I think they learned the use of cotton for raiment from thence. 7thly. It will not be doubted but the Eleusinian mysteries were derived to the Greeks and Romans from Egypt. But capt. Wilford in the 5th vol. of the Asiatic researches has shewn that the concluding words Κογξ ομπαξ are of Hindoo origin. Other considerations might be added, but it would occupy a volume to substantiate and defend these. The reader therefore must adopt them or otherwise as his better information will enable him to decide. Sir W. Jones is of opinion that by means of the Puranas, all the learning of the Egyptians may be traced, without need of decyphering their Hiroglyphics.

There is a coincidence worthy of remark between the feast of Lamps of the Egyptians (Herod. Euterpe 62.) and the customs of the Chinese in this respect.

I have called Palibothra, Canoge. Rennell thinks it was Patna. Helibas, is Allahabad, which last Dr. Robertson thinks was Palibothra.

Note 23. *Beer.* In addition to Herodotus, see Diod. sec. l. 1. 13. Dioscorid. l. 2. c. 110. 22 Plin. 5. ad finem. In his fiunt et potus Zythum in Egypto, Cælia et Caria in Hispaniâ, Cerevisia et plura genera in Galliâ aliisque provinciis.

Ovid in his Metamorphoses mentions that when Ceres applied to some old woman for drink, she gave her a liquor made out of dried grain.

Note 24. *Oil.* I have already noticed that the Greeks in the time of Homer did not know the use of olive oil for burning. Yet Pliny who treats pretty much at length on the subject of oil (15 Plin. c. 2, 3, 4, 5, 6, 7 and 19. Plin. 5.) says with little good temper, usum ejus ad luxuriam vertêre Græci, *vitiorum omnium genitores*, in gymnasiis publicando. In L. 15. ch. 7. speaking of the Egyptian oil, he says, Plurimum autem in Egypto, è raphani semine, aut gramine herba, quod chortinon vocant. Itèm Sesama et Urtica, quod cnecinum appellant.

I cannot tell what the Gramen and the Urtica were. The oil from rape was used many ways; the sesamum oil was an ingredient in their cookery, as it is to this day.

There can be no doubt but the Hebrews brought their knowledge in this respect from Egypt.

NOTE 25. *Pitch and Tar.* 15 Plin. 7. (Oleum) à pice fit, quod picinum appellant, cum concoquitur velleribus supra halitum ejus expansis atque ita expressis. probatum maximè è Brutiâ Est enim pinguissima et resinossissima. Hence the oleum picinum, or pitch oil, was the vapour of burnt pitch, received by wool, and then expressed. So also, 16 Plin. 11. Lignum (tæda) concisum, furnis undigue igni extra circumdato, fervet Primus sudor aquœ modo fluit canali. Hoc in Syria cedrum vocatur, cui tanta vis est, ut in Egypto corpora hominum defunctorum eo perfusa serventur. (This could not have been a mere pyroligneous acid, but something like our spirits of turpentine.) Sequens liquor jam crassior picem fundit.

NOTE 26. *Linen.* See 20 Gen. 16. 24 Gen. 65. Sarah,s veil. Weaving 14 Gen. 23. 7 Job. 6. 41 Gen 42. The Hebrew word *shesh*, fine linen as it is here called, may be either linen or cotton. By comparing (says Dr. Parkhurst, Heb. Lexicon) 24 Ex. 4. and 26 Ex. 1. with 2 Chron. c. 2. v. 14. and 26 Ex. 31. with 2 Chron. c. 3. v. 14. it appears that *Buts* or cotton is called shesh : and by comparing 28 Ex. 42.

with 39 Ex. 28. that *Bad* or linen is also called *shesh*.

See Herod. Eut. and 38 Justin ch. 8. for the transparent drapery of Ptolemy Physcon. Quam fœditatem nimia subtilitas *perlucidæ vestis* augebat; prorsus quasi astu impicienda præberentur, quæ omni studio occultanda pudibundo viso erant.

The transparent drapery and invisible petticoats of our modern belles, were not unknown in ancient times. Femineum lucet sic per bombycina corpus—calculus in nitidâ sic numeratur aquâ—says Martial L. 8. epig. 68.

It is true the Bombyx was the silk worm; but silk will answer this purpose: tho' as the Charta Bombycina at the close of the Byzantine times, was clearly cotton paper, the word may mean cotton here also.

Dr. Geo. Somers Clark in his "Hebrew criticism and poetry" lately published, thus translates 3 Isaiah 16—24.

Moreover hath said Jehovah: because that
The daughters of Sion are haughty;
And walk with extending the neck,
And coquetting with their eyes
Imitate children in their walk,
And upon their feet tinkle rings;

Jehovah will therefore humble the head of
The daughters of Sion and their shame he will uncover.
In that day the Lord will take away
The ornaments of the ankle-rings,
And the netted bandeaus, and the crescents,
The lockets, the *Glasses*, and the veils,
The plumes, the sandals and the zones
And the *medallion-miniatures*, and the amulets,
The rings and the jewels of the nostril,
The pelices and the robe, and the vests and the stockings
The *Revealers*, and the shifts, and the turbans and the shawls——

And there shall be instead of perfume, putrefaction;
And instead of elegant attire, rags,
And instead of uniform covering, nakedness,
And instead of a scarf, a belt of sackcloth.
And carbuncles instead of beauty.

I do not know Dr. Clark's authority for substituting glasses, for bracelets; or medallion-miniatures for tablets. The word means perfume-boxes, which were usually suspended to the neck chains. But in substituting *Revealers* for changeable suits of apparel, he follows Dr.

Lowth and Dr. Stock, who translate the phrase, *a vest which does not conceal what it covers.*

In the days of our worthy ancestors who translated the Bible under the auspices of James the first, there were no transparent draperies, or invisible petticoats afloat; so that the expression in the original must have been almost unintelligible to those grave and learned men; who adopted "changeable suits of apparel," for want of having distinct examples of the original before their eyes.

Panoplis was the most famous place for the manufacture of linen in Egypt. Cotton was the produce of upper Egypt. Pliny l. 19. c. 1. describes the plant. The Byssus was no doubt COTTON cloth, which was in early use. 19 Plin. 2. The ancients bleached in part by means of quick lime. Theophrastus mentions the burning of a vessel partly laden with linen, and partly with lime.

NOTE 27. *Common Salt*, was used as now for preserving meat 31 Plin. 7. The Egyptians used natron for the same purpose, which the practice of embalming would naturally suggest. See page 32 of the lecture. Charles V. of Spain, erected a statue in honour of G. Berkel who discovered the method of curing herrings with salt; yet the salting of fish was known in Egypt so long ago as the reign of Mœris, 1 Diod. sic. 62.

NOTE 28. *Natron.* I have already advanced my reasons for believing this to be the alkali of soda. But I do not pretend, that it did not also contain calcareous or cubic nitre or both. Its use in embalming, and in preserving meat, seems to indicate this.

Sal Ammoniac. Flos salis non fit, nisi aquilonibus. In igne nec crepitudo, nec exilit tragasœus, neque acanthius, ab oppido appellatus, nec ullius spuma, aut ramentum, aut tenuis &c. 31 Plin. 7. Bergman thinks this flos salis, may have been sal ammoniac. De primord. chem. p. 27. note f. I cannot well understand Pliny's chapter (12 Plin. 23.) on sal ammoniac and sphagnum.

Alum. 35. Plin. 15. There is some difficulty in determining, whether this always meant one and the same substance among the ancients. I cannot make out the distinction between the supteria of Dioscorides, the alumen of Pliny, the skisy, the trichitis, the nigra or the liquid alum. The nigrum was used to *purify* gold: that is I apprehend, to clean the surface of it; for which purpose I believe burnt alum and spirit of wine are used at the present day.

Soap. An invention of the red haired Germans according to 28 Pl. 12. (rutilandis capillis) they made it both hard and soft, of suet and the ashes of the beach wood. The men says he, make more use of it than the women.

Note 29. *Method* of separating gold from the ore, as described by Diodorus Siculus. The black earth had veins of white marble. The ore was roasted to render it frangible. It was then ground or stamped. By washing and inclination, the earthy parts were gradually separated. Certain proportions of lead, salt, tin, and bran, were then added to, and mixed with the residuum which was exposed to the heat of a furnace in a covered crucible for five days and nights. This produced pure gold (aurum obryzum) without any scoria. I have seen somewhere in Nicholson or Tilloch, an elaborate explanation of this process, but I cannot refer to the passage. Gold I believe has never yet been found other than in a metalline state; doubtless now and then alloyed, with silver, platina, or copper, but although this ancient method would scorify the baser metals, it cannot I think be regarded as very scientific.

Note 30. *Serpents of gold* on the breast-plate of the high priest Heliodorus; black, yellow and of other colours. Bergman thinks they were enamelled. I think they might have been painted with coloured varnish, a kind of megilp; and varnished again. Bergman de prim. chem. p. 30. who cites Æth. l. 3.

NOTE 31. *Papyrus* The ancients wrote, 1st, on smooth lead. Hesiod's poems, deposited in the temple of the Muses at Bœotia, were so written. 2dly. On boards planed smooth: on such were the laws of Solon written, in Boustrophedon lines. These were the *libri in schedis* the common books of the Romans. 3dly. *Libri cerei*, boards planed and waxed. These were written on with an ivory or metal pointed pen; hence *stylum vertere*, one end being used for writing, the other for erasure. 4thly. *Libri lintei*, where the wooden tablet was covered with linen; on such were the sybylline books, and some ancient laws written: sometimes I presume with atramentum; but Drummond and Walpole in their Herculanensia, Diss. 7th, say the linen was waxed. 5thly. *Libri in coria*, mentioned by Ulpian, lib. 52. were such, as had an under layer of leather, to prevent the transparency of the first layer: as I think from the description in 13 Plin. 12. 6thly. The *membrana*, which I also suspect to be a kind not so well dressed as 7thly. the *pergamena carta*, which approached our parchment: a manufacture promoted by Eumenes king of Pergamus. 8thly. Bark, paper *è cortice tœneotica.*

9thly. Coarse wrapping paper used by tradesmen, made out of coarse paper and straw, *emporetica*. 10thly. The *Papyrus*. Consistence was given to all these by size, or by paste, made of flour, or by boiling the crumb of fine bread. The membrana charta, the charta coriacea, the pergamena charta, and the charta papyri, were all liable to be moth eaten. "aut tineas pasces taciturnus inertes" Hor. Ep. 20. For the various other denominations of paper, as the *Hieratica*, or paper for religious treaties, the *Liviana*, and *Augustina*, or royal paper, the *Fanniana* from a paper-maker of that name, the *saitica* from Sais in Ægypt, *tæneotica*, the *emporetica*, &c. I refer generally to 13 Pl. 12.

The charta è corio mentioned by Ulpian, I have already noticed. Justinian whose institutes were published in the year 533 of our æra, enumerates tables, paper and dressed skins. Literæ quoque licet aureæ sint, perinde chartis membranisque cedunt 2 Inst. tit. 1. § 33. Sed si in chartas tuos libros tuasve membranas, (qu. does not this imply that the parchment was not used for books?) Ib.

Nihil autem interest, testamentum in tabulis, an chartis membranisve, vel in alia materia est. 2 Just. Inst. tit. 10. § 12. Hence also it appears that the letters were sometimes gilt; (embossed and burnished, from whence I suspect arose the practice of illuminating Missals.)

The paper books attributed to Numa, were certainly forgeries, as appears from the anachronism of their containing pythagorean tenets. 13 Pl. 12.

The papyrus, whence our appellation paper, deserves further notice.

The papyrus according to Pliny, was made of the thin pellicles (phylyra) of the stem of the plant called papyrus growing in the Nile, about 10 feet high, in about 3 or 4 feet water. (Bruce has given a plate of it.) The centre coat was best. When separated by a sharp pointed instrument and laid across each other at right angles, they were moistened, then pressed, and dryed in the sun. Generally the saccharine mucilage of the plant itself (a great part of which was an article of food) was sufficient to give an even and smooth tenacity to the pellicles thus separated, when pressed. If not, they were moistened with a kind of paste or starch made of wheat flour and vinegar; then dried, and beaten with a mallet. Sometimes with a paste made by boiling bread and straining it. The Romans under the emperors, used to polish the papyrus thus treated with smooth ivory, and subject it to rollers and presses.

In making up a book, the written paper was rolled on a stick or roller, *umbilicus:* the ends of the umbilicus *cornua* were much ornamented. So was the outside of the volume, (volumen, roll) called *frons*. The title συλλαβος (whence our syllable) was then stuck on the outside. The whole volume might be about three feet wide and forty or fifty feet long. The books found at Herculaneum and Pompæi according to the late report of the rev. Mr. J. Hayter, whom the Prince of Wales employed about ten years ago, to examine and unroll them, are of papyrus upon wooden rollers: the leaves are from one to three feet broad, and when unrolled extend from thirty to forty feet. He says the ink contains much gum, and no acid. Hence it should seem that they were written on by means of a reed (calamus) dipt in the atramentum librarium of Pliny, which was fine size and lamp black. It was common to insert a piece of parchment between every four or five leaves of papyrus, to support them. Much pains was taken by the paper makers and book binder: thus Horace ad librum suum, epist. 20.

Vertumnum, janumque liber spectare videris

(That is you will be sent to the Forum, where these statues were erected.)

Scilicet ut prostes, SOSIORUM pumice mundus.

Polished with the pumice, and for sale at the bookstore of the Sosii.

Sometimes the leaves before writing were first polished with a tooth. 13 Pl. 12. For more on the subject of papyrus see 5 Herod. 58. 4 Theoph. 9. 13 Pl. 11, 13. Drummond and Walpole's Herculanensia, Dissertation, 8th. and Bruce's travels, who has given a good plate of the papyrus.

Job xxxi. 35. talks of writing a book: I think with many divines, this is a sacred drama of eastern origin. If so, this book implies the use of papyrus at an early date. See 1 Gog. 187.

Phylyra 13 Pl. 11. is not only the name for the finer interior filament of the papyrus, but of the maple, the sycamore, the beech, the mulberry and the linden tree, all which were occasionally converted into paper, when sized, beaten, dried and rolled. The common paper in the time of the emperors was from nine to twelve inches square.

The papyrus paper was succeeded by paper made of cotton, or at first perhaps of silk; for although the cotton paper acquired the name of charta bombycina, yet it is highly probable, that the refuse silk was first applied to this purpose, as in China. The Indian or finer silk, was sericum (inter sericos jacet pulvillos) the inferior or Syrian silk was the bombycinum. By and by, the frauds of the paper makers, substituted the byssus or cotton, but still it was sold as silk paper: till coming into common use, all the cotton paper, retained the name of charta bombycina. The papyrus continued in use at Rome from about 200 years before Christ to the end of the eleventh century, when many of the papal bulls according to Father Mabillon were written on papyrus. Montfaucon mentions a manuscript on this paper in the king's library at Paris of the date 1050. Parchment was also still in use at the same period.

NOTE 32. *Aristotle.* I think this Philosopher may be regarded as the first in rank among the persons to whom the ancients gave that title. I profess to be indebted to Dr. Gillies's translation of his Ethics and Politics in 2 vol. 8vo. for the passages that seem to authorize the following brief enumeration of what may be called his discoveries, and the subjects on which he wrote. I have collected them from scattered observations, and passages referred to in that work.

Aristotle, seems first to have stated that the senses were the only inlets to ideas: though the common citation, *nil fuit in intellectu quod non prius fuerit in sensu*, does not verbally belong to him. Hence he forestalled Locke's doctrine of no innate ideas. A doctrine, which the shallow metaphysics of modern days, will oppose in vain. He lays it down also in substance, as Locke has done after him, that the sensible qualities of bodies, exist only in our perceptions: but he does not (like Berkeley) reject a material world: for he decides that the cause of our sensations, or in modern language *perceptions*, must be something ab extrâ. He had a glimpse of the doctrine of the association of ideas, so far at least as to preoccupy Mr. Hume's general classification of association, to wit, proximity in time, contiguity in place, resemblance or similarity, contrariety or contrast. It is true, he has not presented us with any thing like the demonstrative evidence of Hartley; for what mortal can know or foreknow all that is, or that is to be known? but he certainly went as far as Mr. Gay or Mr. Hume. Indeed the latter ought to have understood the subject better than he did; for Hartley's book was published in 1749. Dr. Beattie was too superficial to understand Hartley, Dr. Reid did not take the pains to understand him, and Dr. Dougal Stewart writes on the subject with almost as little knowledge as his predecessors in the school of Scotch metaphysics. In fact, all metaphysics not built upon physiology, is little better than unmeaning jargon.

He (Aristotle) grasped at the great truth, so laboriously and learnedly illustrated by Horne Tooke that, the substantial forms of the ancient dogmatisers, and of the realists among the schoolmen, as well as the abstract ideas of Locke, and his followers, *are words only*, without any real archetype in nature. Words, invented for the purpose of abridging and expediting the processes of reasoning; and by aid of words, when the meaning has been precisely and accurately fixed, many important processes may be employed and many important truths discovered, by comparing the properties and relations of these artificial signs. And who does not know how much has been done in this respect by investigating and comparing the properties and relations of the arbitrary signs which form the language of algebra and the mathematics? The Nominalists were probably the teachers of Mr. Locke himself, whose book as Horne Tooke truly observes, relates more to grammar than to metaphysics.

The two great arguments for the proof a of Deity, are classed as á *priori*, and á *posteriori*. A priori, inasmuch as nothing can exist without a cause of its existence, and an infinite progression of causes is an absurdity. Aristotle uses this argument, and I do not know that Dr. Clarke has added to it any thing of importance. The argument à posteriori relyed on by modern theologians in preference, is, that the whole of nature, all the objects known to us, animate and inanimate, are so manifestly formed, arranged, and governed, according to a system implying design far more than human, both in the aggregate, and in each individual, that it would be as absurd to deny that a watch was made for the purpose of ascertaining the division of time, by some artificer extraneous to the watch itself, as that the heavens and the earth, animals, plants and fossils were not constructed under the guidance of intelligence, forethought and design, in every instance where man has the capacity to discern them. Adopting the à posteriori argument, Aristotle reasons to a first cause, from the wisdom, and knowledge manifestly displayed in the system of the heavenly bodies: and this first cause he determines to be ONE, or God.

As to the human soul, he argued that as the voluntary principle which confers on man the exclusive power of reasoning comparing and judging of right and wrong, cannot belong to Matter, it is an energy, characteristic of some being different from the material human frame It is true, he also supposed a sentient principle and a principle to which must be ascribed appetites and desires: and like many other of the ancients, he seems to have had no distinct notion of the separate existence of the human soul, as a subject of future reward and punishment; but supposed like the Mystics of later times, that it was absorbed after death, into the spiritual and eternal source, whence all souls originally emanated.

Aristotle was the inventor of the art of reasoning by Syllogism, an art, which however abused by the logomachies of the schoolmen, has not a little contributed to just and conclusive reasoning. Of his metaphysics I say nothing, first because I have not sufficiently studied the original to understand them with facility, and secondly because all metaphysics, like all physics, must consist if true, on propositions ultimately deduced from a careful notation and comparison of physical and physiological facts. The term metaphysics, has been adopted, because the books of Aristotle treating of this subject are arranged after his physics.

It would lead me too far to enter into an account of the prodigious collection of facts he has registered in natural history and natural philosophy. It may suffice as relating to our present subject to mention, that he first has noticed the weight of the air, stating that a bladder full of air is heavier than when empty. It is enough to say of him that Pliny (l. 8. c. 19.) takes him for his guide, and that modern discoverers, have expressed their astonishment at the extent and accuracy of his knowledge (Cavolini on Fishes 1 Gillies 149.) even Buffon himself despairing to rival the merit of the natural history of this ancient, has conceded to him the palm. 1 Buff. Hist. Nat. 63. Indeed the magnificent prodigality of Alexander, in furnishing all the means of knowledge, gave Aristotle advantages beyond any philosopher of his day, and that he made good use of them, the panegyric of the elder Pliny would of itself be sufficient to prove.

Aristotle was for many years the intimate friend and instructor of Alexander who sent him (according to Athenæus) during the Persian expedition the enormous sum of 800 talents for the improvement of science. 7 Plin. 29. 8 Plin. 16. 9 Athenæus 398 ed. Casaub. Alexander also enabled him to rebuild his native city; he spared Eressus in Lesbos, because Theophrastus and Phanias two of Aristotle's disciple were born there. He transmitted to Aristotle from Babylon, the astronomical tables preserved there for 1900 years, and remounting

2234 years before the christian æra (Porphyry apud Simplicium de cœlo, cited by Gillies Arist. Politics and Ethics, v. 1. p. 150.) and at various times an immense collection of Zoology, which he employed persons to procure in all manner of ways through different parts of Asia, and of Greece.

From the same attachment to learning and learned men, this great conqueror spared the house of Pindar; slept with Homer under his pillow, and during his expedition, wrote to Athens for the works of the tragic poets, with the Dithryambics of Telestus and Philoxenus and the history of Philistus. Plut. in Vit. Alex.

The expressions of Pliny strongly mark Alexander's thirst for knowledge, as well as the immense collection in Aristotle's power, and the laborious industry of Aristotle himself.

Aristotles diversa tradit, vir quem in iis magna secuturus in parte præfandum reor. Alexandro magno rege, inflammato cupidine animalium naturas noscendi, delegatáque hac commentatione Aristoteli, summo in omni doctrinâ viro, aliquot millia hominum in totius Asiæ, Græciæque tractu parere jussa, omnium quos venatus, aucupia, piscatusque alebant: quibusque vivaria, armenta, aviaria, piscina, aviaria, in curâ erant, ne quid usquam genitum ignoraretur ab eo. Quos percontando, quinguaginta fermè volumina illa prœclara de animalibus condidit. Quæ à me collecta in arctum cum iis quæ ignoraverat, qæuso ut legentes boni consulant in universis rerum naturam operibus, medioque clarissimi regum omnium desiderio, cura nostra brevitèr peregrinantes. L. 8. ch. 16.

The combination of science with military tactics which distinguished all Alexander's expeditions, and the many magnificent plans he had noted among the memoranda found after his death, for the purpose of promoting the mutual interests and communications of Greece, Persia and Asia, are mentioned by Arrian and Diodorus Siculus, but Dr. Robertson has collected most of them in the eight first notes to his historical account of the Knowledge of the Ancients respecting India, which every student will take care to read.

NOTE 33. *The Shield of Achilles.* Homer mentions gold, silver, tin, and copper, as entering into the composition of that shield, 18 Iliad 474 at seq. Indeed frequent mention is made by Homer of gold shields, as that of Nestor, of Glaucus, &c. But iron was a scarce commodity at that time, and the weapons, and even tools were made of copper. In the games celebrated by Achilles on the death of Patrocles, an iron ball is proposed as one of the prizes. See on these points 28 Il. 826. 7 Il. 473. 23 Il. 118. 3 Odyss. 435 and 5 Odyss. 244; and the explanation of the shield given by Pope, as a note to the passage.

Note 34. *Nepenthe.* Diod. sic. L. 1. p. 87, 88. 21 Plin. 21. Odyss. Delta 221. There is a very learned and ingenious dissertation by Kæmpfer, on the Arabic generic word Kaif. This comprehends every exhilarating, and narcotic substance, as opium, tobacco, &c. &c. so coffee for the same reason is kaif; hence the word coffee; meaning an exhilerating beverage. I cannot now refer to the passage in Kæmpfer, but I think the dissertation is among his Amænitates Japonicæ.

Note 35. *Sugar.* Theophrastus mentions it as the honey of a reed, Calamus. *Saccaron* et Arabia fert (says Plin. l. 12. c. 8.) sed landatius India. Est autem mel in harundinibus collectum gummi modo candidi, dentibus fragile, amplisimum nucis avellanæ magnitudine, ad medicinæ tantum usum. This seems to have been refined sugar.

Note 36. In the Dactyliotheca of *Abraham Gorlæus* of Antwerp, whose collection was afterwards sold to the Prince of Wales, the first part contains only the metalline seals. " Dactyliotheca: sive annulorum sigillarium, quorum apud priscos, tam Græcos quam Romanos usus in ferro, ære, argento, et auro, promptuarium;" the second part contained the stone-engravings, " Variarum gemmarum, quibus antiquitas in signando uti solita, sculpturæ." 1601. the best edition Leyden 1695.

This book, with Tassie's descriptive catalogue, and *Worlidge's* engravings from ancient gems, which is now so scarce, that it ought to be republished by some artist of equal merit, will give a tolerable idea of the skill of the ancients in this respect.

Alexander's troops were supplied with coin struck in the camp. The author of the sketches concerning the Hindoos, says, that Greek coins, medals, and engravings, are found in India. That he had seen two Cameos of exquisite workmanship, and that a beautiful medal of Alexander, about the size of a half crown piece, was found and presented to the Nabob of Arcot v. 1. p. 89. note. 2nd edit. Raspe (a learned man) in his Introduction to Tassie's descriptive catalogue of engraved gems, is of opinion that the art of engraving precious stones, is of Indian invention. The legends on the Indian gems inserted in that catalogue, are in the Sanscrit language, and therefore of great antiquity.

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NOTE 37. *Filtration: Calcination: Distillation:* Plato in Symposio. Hippocrates de Hemorrhoid. et alibi. Galen de sanitate tuendâ, l. 4. c. 8. Galen de medic. simp. fac. l. 9. Dioscorides Mat. Med. l. 5. c. 110. Pliny. Patinis fictilibus impositum (minium, that is Cinnabar) ferrea concha calice (ambix) coopertum argilla superillita: dein sub patinis accensum follibus continuo igni, atque ita calicis sudore deterso, qui fit argenti colore, et aquæ liquore. 33 Plin. 8. The parallel passage in Dioscorides is, In fictilem patinam ferream, habentem concham, cinnabaris conjicitur: postea veró ambika imponunt, et luto circumlinunt, carbonesque subtus accendunt, quæ ambiki postea fuligo inhærit; derasæ, refrigerataque *Hydrargyrus* est. Dioscorid. l. 5. c. 110. Vitr. l. 7. c. 8. Athenæus Deipnosoph. l. 2. p. 480. edit. 1612. 2 Goguet 63. According to Athenæus in the passage referred to, the Ambix was the lid of a pot. The Arabian Chemists when they added a neck to it, added the prefix *Al* to the appellation; Alembic. Athenæus mentions the glass works at Lesbos. Galen however was certainly ignorant of distillation in the proper sense of the word; for he exclaims (De med simp. fac. l. 1.) non multum abest, omnia vellem subire pericula, si quam machinam, artemve invenire liceat sicut in lacte contrariarum partium, sic et in aceto, separandi. Galen knew the preparation of common alkaline salts by lixivation and evaporation, but it does not appear the ancients knew how to render them caustic, or free from carbonic acid. Ib. c. 14.

NOTE 38. *Greek fire*. The account is given by Cedrenus. It is said to be rediscovered by the Librarian of the Elector of Bavaria from a description in an old latin manuscript, sulphur, resin, alcohol, camphor, and nitre: are stated to be the chief ingredients. Parke's Ch. Catechism. fourth edit. p. 509.

A count Rzewieski at Vienna, is also said lately to have found the receipt in an Arabian manuscript, together with some notices of gunpowder about the time of the Croisades. Alcohol and camphor seem to me, ingredients too expensive for the Greek fire.

The following passage is from the travels of Bertrandon de la Brocquiere in 1432 and 1433. p. 117. (Johnes' translation) " While this was passing, the Canon of the " Castle was fired, and the people of the town (Damascus) " launched into the air bien hault et bien loing, une ma- " niere de feu, plus gros que le plus gros fallot que je " veisse onques allumè ——They told me they some- " times made use of such at sea, to set fire to the sails

" of an enemy's vessel. It seems to me easily made and " at little expence and might be used to set fire to " camps."

NOTE 39. The Greeks in Homer's time probably understood dying tolerably well, for he mentions Helen as employed in representing on embroidery the bloody fights of the Greeks and Trojans. 3 Il. 125. and Andromache as working flowers in embroidery 22 Il. 440. Goguet thinks this does not imply variety of colours. I am of a different opinion.

NOTE 40. The iron heater to the modern Tea-urn, as well as the elegant form of this very convenient and beautiful appendage to the tea table, we owe to the Romans. Sansom's letters: Account of Pompeii.

NOTE 41. The substances used in medicine (too many to be enumerated) may be found in Pliny, in Dioscorides of Anazarba, and in Galen. The colours employed by the ancients, I endeavoured very laboriously to ascertain by a search into these authors, Theophrastus, Oribasius, and Solinus, and detailed them in a note to a memoir on the art of Painting among the ancients, read at the Philosophical Society of Manchester, Dec. 21, 1785, and published in the third volume of their Transactions. I do not quote it here, because the editors of the Edinburgh Encyclopœdia (Dobson's edition) article Painting, have thought proper to copy nearly the whole of my memoir verbatim without acknowledgement.

Pottery. I have said little on this subject in the Text and indeed I do not think the skill in the art of brick-making among the Egyptians of much importance, nor have we any precise account of the manufacture of pottery at the Greek settlement of Naucrate. The wisdom of Jesus the son Siracn, ch. 38, notices glazed earthen ware.

The Fictilia of the Romans required little skill; nulla aconita bibuntur fictilibus; says Juvenal. The Etruscan forms the outline and shape of their vessels, however, had grea merit; and Mr. Bentley (Wedgewood and Bentley) greatly promoted the pottery of England by his judicious selection of the more elegant specimens for imitation. Sir W. Hamilton has bestowed more labour on this subject than it merits; and copied with needless accuracy the disgusting figures which the gross and depraved manners of the ancients, led them to regard as ornaments, with very little credit to their decency or their taste. It is worth noting that after the taking of Alexandria, a porcelain vessel was the only part of the spoil retained by Augustus.

I give no account of that most beautiful, indeed most superb specimen of ancient pottery, which modern art has not yet equalled, the PORTLAND VASE, because Dr. Darwin's description of it is in every body's hand.

I have said the Greeks were indebted to the Egyptians: 1 Diod. 69. 81. 96. and 2 Diod. 4. observes that Orpheus, Musæus, Melampus, Dedalus, Homer, Lycurgus, Solon, Plato, Pythagorus, Eudoxus and Democritus, all travelled into Egypt for the purpose of acquiring knowledge. But I cannot find satisfactory evidence that any of them brought home much more than a knowledge of words rather than of things, excepting perhaps Democritus of Abdera, who had a turn for scientific pursuits, and spent most of his life in making experiments. The account of him in Bayle, is a very unfair tissue of all the absurdities truly or falsely ascribed to him.

NOTE 42. I shall notice the knowledge of *Gunpowder* in the East, presently.

NOTE 43. The *Chinese of Hindoo origin.* M. Le Gentil, and M. Bailly strongly incline to the opinion that the Chinese are of Hindoo origin: and sir W. Jones "after long and anxious enquiries" is of the same sentiment. 1st The Buddha of the Hindoos (Hindūs) is the

Fo of China. 2dly. They believe like the Hindoos in five order of Genii, to whom they offer victims in high places, as the Hindoos also do. 3dly. The funeral rites of the Chinese, and the Sraddha of the Hindoos are much alike. 4thly. According to Bailly, the Chinese fabulous history, seems to comprize somewhat of the ancient historical accounts of the Hindoos. 5thly. Both nations have a remarkable attachment to the number nine. 6thly. They resemble each other in their observance of the solstitial and equinoctial sacrifices. 7thly. In making offerings to the manes of their ancestors. 8thly In their dread of dying childless. 9thly. In observing the eight cardinal points of the world. 10thly. In their division of the Zodiac &c.

To all which Mr. Barrow (Travels in China) objects the great dissimilarity of feature : to which it may be replied, according to the opinion of sir W. Jones, that, four thousand years separation, and long intermixture with the Tartar or Tatar race, is quite sufficient to account for any dissimilarity of this kind.

NOTE 44. The *Egyptian* feature. Herodotus says they were black. Euterpe. M. Volney assured me the face of the Sphinx bore the physiognomy of a negro. So according to Sansom's letters do some remaining Egyptian idols.

NOTE 45. *Gunpowder.* I have already noticed the conjecture of Dutens, that the story of Salmonius was allusive to the knowledge of gunpowder. The following citations on that subject I owe to the same author. Origine des decouvertes, &c. v. 2. p. 83. et seq.

Dio Cassius, Hist. Roman. in Caligula p. 662, machinam habebat quâ tonitribus obstreperet, ac contra fulgura, fulguraret, ac quoties fulmen decidisset, lapidem ejaculabatur. (I give the latin because I cannot procure greek type here.) To the same purpose Joannes Antiochenus, whom Dutens appears to quote from the Peiresciana edited by Valesius Paris 1634. in quarto page 804.

Agathias the Historian says that Anthemius of Tralles having a dispute with Zeno the Rhetorician his neighbour, destroyed his house with thunder and lightening. Agathias Myrenæus de rebus gestis Justinianna, l. 5. p. 151. Greek and Latin Paris 1660 fol. A little before, he had mentioned the artificial earthquakes of the same Anthemius.

Philostratus in his life of Apollonius says, Indorum sapientes (the Bramins) si ab hostibus invaderentur, non prodiisse in aciem sed *prēstēras kai brontas* in illos veluti de cælo immisisse. Philost. vit. Apoll. l. 2. c. 33. and l. 3. ch. 3.

Julius Africanus mentions a composition proper to project against an enemy advancing, but this may be merely fire balls. Jul. Afric. in Kestoi ch. 44. p. 303.

Doctor Jebb, who edited the works of Roger Bacon, gave M. Dutens from among the manuscripts of Dr. Mead, the following extract, from a book in the Royal Library at Paris entitled Incipit LIBER IGNIUM à *Marco Græco* perscriptus, cujus virtus et efficacia est ad comburendum hostes tam in mari quam in Terrâ. At page 9 of the manuscript were these words, Secundus modus ignis volatilis hoc modo conficitur: lib. 1. sulphuris vivi: lib. 2. carbonis salicis: salis petrosi, 6 libras; quæ tria subtilissimè terantur in lapide marmoreo. Postea pulvis ad libitum in tunicâ reponatur volatili, vel tonitrum faciente. Nota, quod tunica ad volandum debet esse gracilis et longa, et predicto pulvere optimè conculcate repleta. Tunica vel Tonitrum faciens, debet esse brevis, grossa, et prædictâ pulvere semiplena, et ab utrâque parte filo fortissimo benè ligata. Nota quod in quâlibet Tunicâ, primùm foramen faciendum est, ut tenta imposita accendatur, quæ tenta in extremitatibus fit gracilis, in medio verò lata et prædicto pulvere repleto. Nota, quod at volandum tunica plicaturas ad libitum habere potest, tonitrum verò faciens quam plurimas du-plicaturas. Nota quod duplex poteris facere tonitrum, ac duplex volatile instrumentum, vel tunicam subtilitèr in tunicâ includendo. Marcus Gæcus probably was somewhat more ancient than the Arabian Mesues, the middle of the ninth century, who cites an author by the name of Græcus. Thus far Dutens.

The use of fire arms appears to have been of great antiquity in India. They are prohibited by the code of Gentoo laws, which certainly are of very ancient date. The phrase by which they are denominated is *Agneeaster*, or weapons of fire: and there is also mention made of *Snetagnee* or the weapon that kills a hundred men at once. It is impossible to guess at the time when these weapons were invented among the Hindoos; but we are certain that in many places of the East which have neither been frequented by Mahomedans nor Europeans, rockets are universally made use of as weapons of war. The Hindoo books themselves universally ascribe the invention of fire arms to *Baeshkookerma* who formed all the weapons made use of in a war between the Good and Evil Spirits. Fire balls, or blue lights employed in besieged places in the night time, to observe the motions of the besieger, are met with every where thro' Hindostan, and are constructed with as great skill as in Europe. Fire works are also met with in great perfection, and from the earliest ages have constituted a principal article of amusement among the Hindoos. Gunpowder, or a composition something resembling it, has been found in many other places of the east, particularly China, Pegu, and Siam; but there is reason to believe the invention came from Hindostan. (8 Dobs. Encyc. 522.) One would be apt to conjecture that Milton borrowed his very fanciful account of the invention of cannon by Satan and his angels, from the Hindoo tradition concerning Baeshkookerma. This account of gunpowder, fire arms, and fire works, will apply to the Chinese as well as to the Hindoos. No doubt the inventions were very ancient, for neither the Hindoos or Chinese are apt to add much the knowledge of their forefathers. The period of inventions in both countries, is far beyond memory, or history.

NOTE 46. *Scholastic Metaphytics*. I do not mean to rank myself with the trifling sneerers at the class of writers called the *schoolmen;* men whose great reading intense application, wonderful acuteness, and strong habits of thinking, afford some of the most extraordinary instances of mental ability that literature can furnish. The Summa Theologiæ is a small part of the works of Thomas Aquinas. I acknowledge in it many feeble arguments, many useless and fanciful divisions, many trifling discussions, but I know of no theologian who has equalled him in acuteness or industry, or surpassed him in extensive views of his subject, and resource of argument, even though his reputation were to be confined to that work. Much of Dr. Clark's reasoning may be found there; and the famous axiom of Newton that we are to admit no more causes than are necessary to explain the phenomena, is expressly laid down by Aquinas in his proofs of the being and attributes of God. Frustra fit per plura, quod fieri potest per pauciora: if indeed it be not more ancient than the time of Aquinas.

Let any one read attentively the well argued book of the English Bradwardine de causâ Dei, and he will find, that much of what has been said on free will, fate, necessity, cause and effect, by Hobbes in his Tripos, by Clarke, Leibnitz and Collins, by Dr. Edwards of America, by Edward Tucker Esq. (Search) by Hume, Lord Kaims, and even by Dr. Priestely, will not be new to him. Their strict adherence to the syllogistic mode of reasoning was carried much too far; but in modern times, this invention of Aristotle is abandoned more than it deserves to be. No man can so skilfully analyse the argument of another, as one who is well acquainted with the rules of scholastic logic, and accustomed to apply them. Good reasoners there are and will be, who know nothing of these rules, but better reasoners who do.

NOTE 47. Recent state of the Iron manufactory of Great Britain. Pantalogia, article Iron.

In the year 1806, when the minister proposed to lay a tax on the manufactures of Iron, the owners of the one hundred and thirty three Iron works, which then exist-in Great Britain, deputed fourteen of their members to assemble in London, and arrange the information which was submitted to the House of Commons, on the bill for passing the tax, with a view of shewing its impolicy and ruinous tendency on a manufacture so essensial to all branches of British Industry.

It is through the kindness of one of these deputies that the following abstract of the Iron Furnaces which were working with coak or pit coal in Great Britain in the spring of 1806 has been made public.

The County of CUMBERLAND has four works, containing four furnaces all in blast which make 1491 tons of pig-iron annually.

DERBYSHIRE has eleven works containing eighteen furnaces of which only twelve are in blast, making 10,631 tons per annum.

Gloucestershire has two works containing three furnaces, of which only two are in blast, making 1629 tons per annum.

Lancashire has three works containing four furnaces, of which only two in blast, making 2500 tons per annum.

Leicestershire has only one work with a single furnace which is now out of blast.

Monmouthshire has three works, containing three furnaces all in blast, making 2444 tons per annum.

Shropshire has nineteen works containing forty two furnaces, of which only twenty eight are in blast, making 54,996 tons per annum.

Staffordshire has twenty five works, containing also forty two furnaces, of which only thirty one are in blast, making 49,462 tons per annum.

Yorkshire has fourteen works containing twenty seven furnaces, of which twenty three are in blast, making 26,871 tons per annum.

South Wales has twenty five works containing forty seven furnaces, of which thirty six are in blast, making 75,601 tons per annum.

North Wales has three works, containing four furnaces, of which only three are in blast, making 2,075 tons per annum.

Scotland has twelve works, containing twenty seven furnaces, of which eighteen are in blast, making 23,240 tons per annum.

So that Great Britain contians in the whole 122 works, and these comprize 222 Coak (charcoal of stone coal) furnaces of which 162 are in blast, and make 250,406 tons per annum, being on an average 1546 tons to each furnace, or about 30 ton per week.

There still remain eleven works in different counties, containing eleven furnaces, all in blast, at which the charcoal of wood is still used. These make 7800 tons per annum; or 709 tons on an average to each furnace.

From this abstract it appears that the 133 furnaces at the period above specified, produce 258,206 tons of pig or crude iron annually: though only twelve years before, the annual produce had been estimated at 100,000 tons. The number of furnaces out of blast or not working at the time, amounted to nearly one fourth of the whole; and this circumstance is attributed in great part to the frequent repairs which the lining and hearth of a blast furnace require: and some had been blown out, or ceased to work in consequence of a temporary failure of supply, either of iron stone or coal, within the owners, or lessees, lands.

At Cyfarthfa in South Wales, the average per furnace is as high as 2615 tons per annum, while in thirteen others, the average quantity falls below 500 tons. At Dewey in North Wales it is stated at one hundred and fifty tons per annum only.

The average quantity made at each of the 122 *coak iron works*, is 2070 tons per annum. Seventeen of these works make 4000 tons each or more. The seven largest are Cyfarthfa in South Wales, 10,460. Old Park in Salop (Shropshire) 8359. Blackmaur in South Wales 7846. Pennydarrau in ditto 7803. Ketly in Salop 7,510: and Carron in Scotland 7380 tons per annum, while at the same time eleven of these works fall short of 500 tons. The three least of these are stated to be, the Golden Hill in Staffordshire 184 tons, Dutton in Cumberland 175, and Dewey in North Wales 150 tons of pig iron per annum.

Ninety five thousand tons of this pig iron, are manufactured in Great Britain and afterward rendered malleable. The capital employed in the manufacture of the raw material only, is estimated at five million pounds sterling, and it furnishes employment to 200,000 persons, independent of all the labour necessary to fabricate the articles of iron.

From the preceding summary it is evident, that the number of wood charcoal furnaces in Great Britain has become comparatively small, owing to the decrease of wood, and the consequent want of fuel: though till about forty years ago they were general in England, as they still are on the continent.

In the reign of king James 1st, this manufacture was in a very flourishing state in Great Britain: but from nearly that period, the progress of cultivation became more rapid, firewood decreased, and the iron manufacture in consequence declined. This decline was so great, that the advantages resulting from this branch of human industry, were nearly lost, untill the process of making iron with pitcoal was established; which has placed it upon such a permanent basis, that it is now capable of being extended to any magnitude without injuring the agricultural interests of the country; as the iron, though it produces so much, costs nothing that is otherwise useful, but the labour of its reduction.

In order to convey in a few words to such of our readers as are not acquainted with the subject, a general idea of the manner in which it is now conducted in this country (England) it may be observed that a blast furnace of the common size, is charged 48 times with eight bushels of coak each time, in the course of 24 hours. To produce this quantity of coaks, requires near 764 bushels of coal per day. The furnace also consumes about nine tons of ore and limestone in the same time. The produce of metal obtained from this consumption is about twenty tons per week in summer, and thirty in winter; when making the best iron, or what the manufacturers call No. 1. and No. 2. the quantity is from thirty five to forty five tons per week.

At many iron works, three of these furnaces and their founderies are constantly in use. The coal and iron mines, with forges and rolling mills for making iron into bars, belonging to the same concern. The great number of steam engines, mills, waggons, horses, workmen, tools, frequently an iron railway or a canal from one part of the works to another, a large farm to maintain the horses, and the capital necessary to prosecute such an undertaking to advantage, will give some idea of the opulence and general knowledge, necessary to enable an iron master to conduct his business with advantage to the community, and profit to himself."

No apology I apprehend is necessary for giving the preceding extract. I would only remark upon it, 1st. That iron can be well made with charred pitcoal: a proposition that has not yet met with full credit even among the iron masters of America. 2dly. That the pitcoal furnaces, produce in the proportion of 1546 tons per annum, the iron furnaces 709. 3dly. That the pitcoal fit for the purpose must be a smoking and flaming coal, not a Graphite. The *bituminous* coals are found in this State, on the Raystown branch of Juniata, in Ligonier valley, at Pittsburgh, and through a large district of the western country. Also at Chingleclamoose on the west branch of Susquehanna; and thence I believe to Sinamahoning, generally through the northwestern counties. The Graphites, or coals that burn *without smoke*, and contain no bitumen, are found on the heads of Lacawana; thence to Wilkesbarre; on both sides the northeast branch of Susquehanna; at Kingston, Plymouth, Nescopeck; and the bed extending up the Lehigh runs across the Berwick turnpike road, and is found breaking out to the day, near the Sunbury and Reading road twenty one miles from Sunbury; and for ought I know, lies under the whole clay-slate formation, for twenty miles further towards Reading. These last will not coak. 4thly. No hammers are mentioned in the manufacturing of bar-iron: it its made by rolling mills, which are now universally used both for bars and nail rods. 5thly Rail ways and canals are objects of economy to private coal works: why should not they be so to the public? 6thly. The English do not depend upon water for power. They bring their power by means of steam engines to the works; they do not confine their works to the neighbourhood of the power. In this country, no situation however advantageous, is thought of, if it does not afford a water fall. In England nobody cares about a water fall. Fuel is plenty in almost every part of that country: yet there is more coal in proportion in Pennsylvania, than there is in England; and to be obtained at less expence.

NOTE 48. The French however have done justice to the merits of Dr. Priestley. The last French edition of Klaproth and Wolf's Dictionaire de Chimie, contains the following remarks on English chemistry. "Besides Van "Helmot, we ought to notice Mayow, Boyle, Hales, and "Black, who had the merit of enquiring after the gasses "till the epoch when Dr. Priestley published his re-"searches. *The first of August* 1774 *ought to be regard-"ed as the birth-day of Pneumatic Chemistry, that being "the day when PRIESTLEY discovered dephlogisticat-"ed Gas.* He likewise became acquainted with all the "other gasses, and in his immense works, always just;

" and never systematic or exclusive, too rich on his own " genius to be induced to borrow from others, he has " published a multitude of new facts that throw great " light on this interesting subject." I have not seen this dictionary: I find the preceding extract in 32 Month. Mag. 578.

Note 49. I shall introduce some remarks on mineralogy at the close of the notes.

Note 50. Alexander. I refer to Note 32, Aristotle: where proof enough in support of this panegyric will be found.

Note 51. Buonaparte. It is to the munificence of this emperor toward literature, that we owe the Recherches Physico-Chimiques of Gay Lusac and Thenard on the imperial galvanic apparatus furnished to the Institute; and that the paper of Mr. Davy of the Royal Institute of London published in the Philosophical Transactions of 1807, was *crowned* at the Imperial Institute at Paris.

In the year 1809, the result of observations made in Egypt by the scientific class appointed to attend the French army in that country, began to be published at Paris at the expence of the emperor: the first number livraison, (three are expected) sold in London on common paper at 84*l.* sterling, on vellum paper at 150*l.* and is said to be cheap at that price. The statistical survey of France began in 1802 at the command of Buonaparte, promises to be a work in all respects worthy of imperial magnificence, and equal in utility with the English agricultural surveys, of which, forty three counties are now published. I mention these instances to shew the attention paid to the promotion of knowledge by the wisest and most successful among the conquerors of the earth; and the connection of knowledge in their opinion, with the lustre of their own character, and the maintenance of national power. Since writing the above, I find that in the beginning of the summer of 1811, Buonaparte sent over a proposal to the ministry of England to permit a mutual interchange of the literature of each nation to a certain amount, which was agreed to. The person employed was M. Wurtz a Paris bookseller. Accordingly, an importation of fifty thousand copies of French books arrived in London last September, (1811) at the bookstores of Mess. De Boffe, Du Lau, and De Conchy. The description of Egypt published at the expence of Buonaparte, and directed to be sold for 84*l.* sterling, it is said could not be executed in the same stile in London, to sell for less than 150*l.* sterling. Another very expensive and magnificent work, has been lately published at Paris under the immediate pratronage of Buonaparte, Monumens anciens et modernes de l'Hindostan en cent cinquante Planches decrits avec des recherches sur l'epoque de leur fondation, une notice geographique et une notice historique de cette contrèe par Mr. De LANGLES; le dessins et les graveures, diriges par A. BOUDEVILLE.

The review of literature since 1789 undertaken by the Institute at the command of Buonaparte, seems to be a valuable work; the authors indeed are partial to the literature of their own country, but not more so I think, than a similar work would be, written in England. Buonaparte no doubt, in all this, aims at the gratification of his own vanity, and exacts the incense of public adulation from the obedient literati of the French capital. Much praise he is certainly entitled to, nor do I hold it a crime of the first magnitude, that he is like other people in the world, somewhat too fond of it. I am not called upon in this place, to the impossible task, of defending generally the conduct or the motives, of this extraordinary man: it is sufficient for me to shew, that the interests of literature have always been deemed objects of great importance, with men of the greatest foresight and most successful talants, that the world has witnessed.

MINERALOGY.

I promised some remarks on this subject, which I submit, not without hesitation.

This science is still in its infancy: nor has there yet been discovered any method of classification free from great objections. Judging of a mineral from its external and physical characters alone, deprives us of the aid of chemical analysis, and of chrystallography, or as the fashion is to call it, chrystallognosie. To take the chemical character alone, will render the science too imperfect, for minerals are very wide indeed in their external appearance, whose analysis indicates but slight variations; and minerals may perhaps be regarded as of the same family as to external character, whose chemical analysis comprehends a wide range in the proportion of the constituent parts. But I know of no use of mineralogy separate from chemistry: I regard it as the chemistry of the eye: a branch only of chemical science; and which never can be made of practical utility unsupported by, and unconnected with chemical knowledge. I suspect that in this country, where the mineralogists are vibrating between the schools of Frieburgh and of Paris, I stand alone in this view of the subject; and a few English mineralogists excepted, and those not ranking in the very first class, the sense of Europe is adverse to this idea. But *nullius addictus jurare in verba magistri*, I shall take my own course in the proposed lectures, at my own risk: and I shall treat mineralogy, merely as a branch of chemistry; (not neglecting however any kind of external character.) I am well aware, that a mineralogist cannot travel with all the apparatus necessary for the chemical analysis of a mineral, and that some nomenclature, connected with external appearance is highly expedient if not necessary: but I prefer for the purpose of a lecture, or even for the arrangement of a cabinet, a classification founded on chemical composition, for the following among other reasons that might be assigned.

1st. There is no such thing as making a mineralogist of any kind, without previous chemical knowledge: this last, constitutes the only leading road to the first, There is no royal path to mineralogy, any more than to the mathematics.

2dly. Whatever anomalies there may be, (anomalies which future knowledge will annihilate) the external character and the form of the chrystal, depends on the chemical composition of the mineral to be examined: but the chemical composition does not depend on the external character.

3dly. The USE and value of every mineral, depends not on its form, or figure, but on its chemical character, and composition. Unless with the few and trifling exceptions of precious stones—polishing stones, corindon, emery, and tripoli—and building stones. Even in the two last classes, resort must be had, not merely to their mechanical, but also to their chemical properties.

4thly. There are far more varieties of external character than of chemical composition in the same mineral. Thus Bournon I understand, has announced near fifty varieties of carbonat of lime, in addition to those enumerated by Hauy; who himself lately (1811) has added to the number. Who would suspect the double refracting spar, or Iceland chrystal, to be a limestone from its external appearance? What two minerals can differ more in external aspect, than the opaque amorphous, and the transparent foliated gypsum, or the rhomboidal selenite? How many minerals are there, having different forms of chrystallization, whose chemical composition is so nearly the same, as to present no practical, or even appreciable difference? How many varieties of chrystallization of the same substance, are enumerated by mineralogists? Is there not something that requires emendation in all this?

To instance but a few. The arragonite is a perfect anomaly among the limestones. The steatite, and the talc steatite, are disposed to put on the chrystallizations of other species. Tab. comparatif 209. 211. Some stones are classed together, whose chemical characters are very different. Thus in the Lazulite, one analysis gives silex 70,23, alumine 22,13 and no soda. Another gives 38,2 silex, 37,1 alumine, and 24,7 soda. Can these be the same substances? So in the Diallage metalloid (shiller spar) one analysis gives 23,33 of alumine, while a variety only of diallage, called the Bronzite, gives but 3: The one gives 29 of magnesia the other 6. Is not this a range too great for varieties of the same substance?

In like manner, the Melanite is domesticated with the Garnet, but chemically it is an Allachroite. Chemically also, aplome, is similar to the epidote of Isere and of Arendal; though its appearance is dissimilar.

Peridot and Olivine—Diaspore and Corindon, are now found by analysis to be the same or nearly so; and this similarity of chemical composition *must* force them into a new arrangement.

The Amphibole (dubious, uncertain) threatens to swallow up a vast number of the particular stones, that formerly were allowed a substantive character, and permitted to stand by themselves. Such as the pyroxene, the actinote, the actynolite, the tremolite, the grammatite, the coccolite, sahlite, malacolite, mussite, and even the schorls and tourmalins. Properly indeed is it named *uncertain ;* but in what respect do we acquire any additional knowledge by being told of a dozen stones, that they are of dubious character ? Surely this is a strange method of classing them ; and it is to be hoped that 'ere long, some learned chrystalognost, will charitably rescue them from the slanderous imputation.

Hauy (3 min. 241) is decidedly opposed to any thing like a transition or passage from one stone to another ; and M. Chevenix, in his very ingenious, but unfair account of the school of Frieburgh, laughs outright at the idea. For my own part, so far as I can depend on my eye-sight, I am satisfied that there is such a gradation ; and even Hauy in his late Tableau comparatif, inadvertently admits it. *La varietè gris du Dissentis, determinèe par M. M. Champeaux et Cressac, forme le passage de l'Epidote ordinaire, au Zoisit d'un gris eclatant.* Tab. Com 185. I am clearly of opinion with La Marck, that the more nature is investigated, the more clearly will it be seen, that the whole system is linked together by means of almost imperceptible gradations.

These remarks might be extended to great length, but they are sufficient to shew, that mineralogical science stands greatly in need of every help that can yet be given to it.

5thly. Mineralogy is certainly of great use, as the short-hand of chemistry. But I fear it cannot stand by itself. Its nomenclature, must be, either empirical or chemical. Werner, and Hauy have laboured hard to give something like a name corresponding to the external character; the one by adopting popular appellations, the other by substituting Greek derivatives. But who can pretend for a moment, that there is any thing instructive, or clearly indicative of mineralogical character in the fanciful appellations of Hauy and his followers; who seem perfectly satisfied with the name, si græco fonte cadat. What correspondence between the sound and the sense, characteristic of the mineral, is there in amphibole, epidote, meionite, telesie, idocrase, pyroxene, and many others of the same description? Why should the white wernerite, be converted into scapolite, and this fantastically changed into paranthine? I would hardly renounce for such far-fetched denominations, even the uncouth sounds of the German catalogue, the homely nomenclature of Werner. I would rather adopt his rock marrow, rock milk, rock butter—his rock soap, rock cork, and rock leather, or even the buttermilch erz of Gallitzin. The French indeed, I see with regret, are adopting terms that to an English ear, convey ideas more gross, than English literature can tolerate. I might pass over the barbarous Goensekoetheges Silber, of the German mineralogist, for what tongue that could avoid, would pronounce the word? but I regret the Argent Merde d'Oie, because French politeness might have afforded us, an appropriate synonime less offensive to the common ideas of delicacy. I do not like to rake the dunghill for a comparison or allusion. French science is one thing; French *grossiertè* is another. I hope we shall not imitate the vulgar servility of a London shopkeeper, with whom the Merde d'Oie, the Caca Dauphin, and the Petenlair, have long been admitted into the fashionable vocabulary of the counter, with the common consent of the men milliners and women milliners of that money making country.

Nor am I much in favour of the modern fashion of designating the names of species, from a place or a person. It seems to me inconvenient without adequate utility. I certainly prefer axinite to thumerstone, and I could wish changes equally preferable at least, could be made in the menachanite, the menelite, the mareckanite, the iserine, the arendalite, &c. Is there no other mineral in America, than the columbium? If indeed this be not a chromat of iron, which I dare say will be found connected with the primitive range of magnesian rocks in the New England States, from whence it came. Still greater objections lie in my opinion to the dolomite, the witherite, the wernerite, the prehnite, the zoizite, the bournonite—much were it to be wished that M. Naargard, had possessed something like a musical ear, when he invented the Hauyene: and had the friends of M. M. Mascagnin and Reuss, permitted us to retain the undisturbed and quiet possession of sulphat of ammonia, and sulphat of soda, we should have been well content to dispense with their new names of mineralogical baptism.

I do not agree with Mr. Smithson in all this. What honour can be conferred on such men as Werner and Hauy. by naming after them a paltry mineral? It is in my opinion a silly sacrifice of utility, to useless compliment.

6thly. All mineralogical systems, and all mineralogical nomenclature, *must be in great part*, founded on chemical properties. Neither Werner nor Hauy can venture to dispense with it, or entirely neglect the chemical analysis of the substance to be classed. Openly or secretly, they are compelled to be guided by it. Werner ranked among the micas, a green foliated substance, which Bergman who had but a grain of it, discovered to be muriat of copper mixed with clay: so much surer (says Kirwan, pref. to the first ed. of his mineralogy) are chemical examinations than external character. What has (among other instances) compelled Hauy to enlarge the class of hornblendes and corindons but the similarity of chemical analysis? for although he has discovered as he thinks, new consentaneous characters of chrystallization, it was the chemical analysis that led him to the search. In fact the time must come when mineralogical like chemical nomenclature will be descriptive; which can seldom be the case without recurrence to chemical composition. If this be rejected, the nomenclature will be arbitrary and empirical as it now is, notwithstanding the very unavailing efforts to make it otherwise. In the present state of the science, the student is confused by half a dozen sets of synonimes from the classification of authors of repute, *that must for the present be gotten by rote*; and must in a few years be carefully forgotten. They may be fairly said, (with very few exceptions indeed,) to rest upon the memory as separate words only.

insulated, and devoid of associations to call them up. He must learn by rote, the German, the French, the Greek, the English, and (of late) the Italian nomenclatures, and synonimes. What do we get by calling Arrow-stone, or Strahlstein, Actinote or Actinolite, or Epidote, or Acanticone, or Thalite or Pistazite? In what respect is Celestin better than blue sulphat of strontian? or Apatite, or Spargelstein, than phosphat of lime? or Cryolite, than the alkaline fluat of alumine? or Mascagnin than the sulphat of ammonia? or Reussen than glauberite? Hornblende, means little, but Amphiboie means less. Telesie may be applied to any perfect chrystal, and Meionite to any small one. In short, of what use is a change of appellation, unless the new name calls up the image of the substance by more numerous, more distinct, and more appropriate associations?

In a few years, we shall be so overwhelmed with synonimes, that we shall become unintelligible to each other, and no student will be able to decide on the language he must adopt.

7thly. While classification depends on external character, even including chrystallization; and while external character leads in so few cases either to the *use* or the *composition* of the substance—classification unless it be treated as a branch of chemistry, must be to a great depth unfixed, unmeaning, and arbitrary, as it long hath been. It cannot be altogether so, if a chemical classification be adopted; the principles of chemistry, being now tolerably fixed, innumerable analyses having been carefully made, and being now daily making, and this part of the science being in a manifest state of progressive improvement.

8thly. I object to the system of chrystallization which Hauy has so beautifully erected on the foundations laid by Bergman and Romè de Lisle, that it is not yet, and I fear never can be, *totus teres atque rotundus*. For

a. The majority of minerals are found in an amorphous state, wherein chrystallization can lend no aid.

b. Of chrystallized minerals, few comparatively are perfect.

c. It requires long practice so to cut a chrystal at its junctions and appositions, as to arrive at certainty with respect to its primitive form. Even Hauy has had to make corrections on this subject, and Bournon is not always of accord with him. It is not sufficient that this can be done with tolerable neatness in a piece of limestone spar; to make the system of practical utility, it ought to be done with ease on every chrystal, but at least nine tenths of chrystallized fossils, do not admit it, even with the practical skill of a lapidary.

d. The number of chrystallizations, including the varieties formed by the laws of increment and decrement, the truncations and bevellings to which the angles are subject, require a continual attention that few persons who are not exclusively mineralogists by profession can or will pay. When the science is founded on laws admitting so many cases that assume the appearance of exceptions, and when the Goniometer is to be applied in every case where certainty is expected, though from the smallness of many chrystals of importance it cannot be applied at all, such a science will hardly prove attractive to a young student, or put on the character of simplicity and demonstration. Taking the minerals in the order they are noticed in the first hundred pages of Jameson, the diamond has five varieties of chrystallization, the zircon as many, the hyacinth four, the chryso-beryl two, the chrysolite four, the garnet four, the spinelle ten, the sapphire nine, the diamond spar two, the topaz nine. I grant, that the intense study of a man so capable as Hauy, may overcome these difficulties, and discover many of the laws by which the apparent anomalies may be reconciled, but to me it seems hardly worth the labour, if after all, we must recur to chemistry alone to know to what useful purpose the mineral can be applied.

M. Chevenix very accurately perhaps in substance remarks, that if he wanted to make a miner, he would send him to the school of Frieburgh.—If he wished to bring him up a scientific mineralogist, he would initiate him in the French school of chrystallography. In this country however, we want miners and practical mineralogists rather than skilfull theorists, and adepts in the art of the lapidary, and the application of the goniometer. When the foundation is laid, by a perfect comprehension of the more general truths, any man who has leisure and inclination, may adopt his own system, and pursue the study through all its ramifications.

I do not know that chemistry can yet afford a complete remedy for the difficulties and defects I complain of: and if it could, I am not vain enough to presume, that I can overcome them. But we are hardly upon the threshhold of mineralogical science: and if in trying to substitute chemical, for empirical appellations, the uncouthness I object to, should be charged upon myself (mutato nomine de me fabula narratur) I shall not be in any degree surprized; for in good truth, I am almost as much aware of it as my reader can be. But in the present state of scientifical classification, the mineralogical world is afloat: every new idea deserves some attention, and although I plead guilty to the charge of uncouthness in the terms I use, they are not like the terms already in use, nearly void of characteristic meaning, as may be asserted with too much truth of the vulgarism of Werner, and the græco-gallic of Hauy.

I think it not amiss to subjoin the mineralogical classifications of the German and French schools, that the student may be enabled by and by to compare the systems, and decide for himself. This is not a tract written for, and addressed to, *professed mineralogists*: *it is intended for* my own class, to whom I mean to make it as useful as the nature of the subject will allow me: otherwise I should not take the present liberty of copying from books, which although well known in Europe, are little known here.

WERNER arranges minerals into Classes, Genera, Families and Species. Mr. Jameson's system of mineralogy is founded on Werner's, but differs in a few particulars from that which I am about to give. Jameson's mineralogy was published in 1804. I shall follow chiefly the work entitled *Traitè clementaire de mineralogie, suivant les principes du professeur WERNER conseiller des mines de Saxe. Par A. J. BROCHANT professeur de mineralogie à l'Ecole des Mines. Second edition. à Paris* 1808. Inserting from Jameson two or three articles that Brochant seems to have omitted. Where the translation varies more than a letter or two from the original, I have given the original word. I find from Hauy (Tab. comparatif.) that Werner has lately made an additional family, Fettstein, or Fatstone, I know not where it is placed. It appears from Mr. Smithson's remarks to be the compact Wernerite or Swedish Natrolite; containing Silex 44, argill 34, ox. iron 4, alkali 16,50. according to Vauquelin.

FIRST CLASS.

EARTHS AND STONES. ERDEN UND STEINEN.

ENGLISH NAMES.	GERMAN NAMES.
I. or Diamond Genus.	
Diamond	Diamant
II. or Zircon Genus.	
Zircon	Zircon
Hyacinth	Hyacinth
III. or Siliceous Genus.	
Garnet Family.	
Chrysoberil	Khrysoberil
Chrysolite	Khrysolith
Olivine	Olivin
Augite	Augit
Vesuvian	Vesuvian
Leucite	Leucit
Melanite	Melanit
Garnet	Granat
precious	edler
common	gemeiner
* *Ruby Family.*	
Spinell	
Sapphire	
† *Schorl Family.*	
Topas	Topas
Emerald	Smaragd
Beryl	Beril
precious	edler
schorloid	schorlartiger
Shorl	Shorl
black	schwarzer
electric	(tourmalin)
Thumerstone	(Axinite)
Eisenkiesel	(iron flint)
Quartz Family.	
Quartz	Quarz
amethystine	amethyst
rock chrystal	bergkrystal
milk	milch quartz
common	gemeiner
prase	prasem
Hornstone	Hornstein
splintry	splittricher
conchoidal	mushliger
Petrified wood	Holztein
Gun flint	Feuerstein
Chalcedony	Chalcedon
common	gemeiner
cornelian	carneol
Heliotrope	Heliotrop
Plasma	Plasma
Chrysoprase	Chrysopras
Siliceous shist	Keiselschiefer
common	gemeiner
lydian or touchstone	
Zeolite Family.	
Obsidian*	Obsidian
Catseye	Katzenauge
Prehnite	Prehnit
Zeolite	Zeolith
farinaceous	mehl
fibrous	fasriger
radiated	strahliger
lamellar	blattriger
cubic	werfel
Cross stone	Kreutzstein
Lapis lazuli	Lazurstein
Lazulite	Lazulit
IV. or Argillaceous Genus.	
Pure alumine	Reine thonerde
Porcellain earth	Porcellanerde
Clay	Thon
common	gemeiner
potters	toepfer
indurated	verhærteter
slate	schiefer
Cimolite	Cimolit
Jasper	Jaspis

* Jameson adds Pyrop, Granatit

†Jameson adds, Corundum Diamond spar and Emery.

* Jameson places Obsidian in the clay genus What business a stone containing 69 per cent of silex has in either place, I cannot explain

egyptian	ægyptischer
ribband	band
porcellain	porcellan
common	gemeiner
Opal	Opal
precious	edler
common	gemeiner
semi	halb
ligniform	holz
Pearl stone	Perlstein
Pitch stone	Pechstein
Adamantine spar	Demantspath
Feldspar	Feldspath
compact	dichter
common	gemeiner
undecomposed	frischer
decomposed	aufgelœseter
adularia	adular
labrador	labradorstein
Polishing slate	Polierschiefer
Tripoli	Tripoli
Alum stone	Alaunstein
Alum earth	Alaunerde

Clay-Slate Family.

Alumslate	Alaunchiefer
common	gemeiner
glossy	glanzender
Bituminous shale	Brandschiefer
Drawing slate	Ziechenschiefer
Whetstone slate	Wetzchiefer
Clay slate	Thonschiefer

Mica Family.

Lepidolite	Lepidolith
Mica	Glimmer
Lapis ollaris: potstone	Topfstein
Chlorite	Chlorit
earthy	chloriterde
common	gemeiner
slaty	schiefer
foliated	blattriger

Trap Family.

Hornblende	Hornblende
common	gemeiner
basaltic	basaltische
labrador	labrado
slate	scheifer
Basalt	Basalt
Wacke	Wacke
Clinkstone	Klingstein

Lava	Lava

Lithomarge Family.

Pumice stone	Bimstein
Green earth	Grunerde
Lithomarge	Stein mark
friable	zerreibliches
indurated	verhærtetes
Sculpture stone	Bildstein
Rock soap	Bergseife
Yellow earth	Gelberde

V. OR MAGNESIAN GENUS.

Soapstone Family

Bole	
Native talc-earth	naturaliche talc-erde
Sea froth	Meerschaum
Fuller's earth	Walkerde

Talc Family

Nephrit	Nephrit
common	gemeiner
Indian hatchet	beilstein
Steatite	Speckstein
Serpentine	Serpentin
common	gemeiner
precious	edler
Talc	Talk
earthy	erdiger
common	gemeiner
indurated	verhærteter
Asbestos	Asbest
rock cork	bergkork
amianthine	amianth
common	gemeiner
rockwood	bergholz

Cyanite	Cianit
Arrow stone	Strahlstein
radiated	asbestartiger
common	gemeiner
glassy	glasiger
Tremolite	Tremolith
asbestiform	asbestartiger
common	gemenier
glassy	glasiger

VI. OR CALCAREOUS GENUS.

A. Carbonats of lime	Kohlensaure kalk-gattungen
Agaric mineral / Rock milk	Bergmilch
Chalk	Kreide
Limestone	Kalkstein
compact	dichter
common	gemeiner dichter

globular or oviform	roogenstein
lamellar	blattriger
granular	koerniger
spathose	kalkspath
fibrous	fasriger
pisolite	erbsenstein
Earth froth	Schaumerde
Slate spar	Scheiferspath
Bitter spar	Bitterspath
Brown spar	Braunspath
Fetid limestone	Stinkstein
Marle	Mergel
earthy	mergelerde
lithomarge	verhærtiter
Bituminous marle slate	Bituminœser mergelschiefer
Arragonite	Arragon
B. Phosphat of lime	Phosphorsaure kalkgatt
Apatite	Apatit
Asparagus stone	Spargelstein
C. Borated lime	Borassaure kalkgattungen
Boracite	Boracit
D. Fluat of lime	Fluss-saure kalkgattungen
fluor	fluss
earthy	erde
compact	dichter
sparry	spath
E. Sulphat of lime	Schwefelsaure kalkgatt.
Gypsum	Gyps
earthy	gypserde
compact	dichter
lamellar, foliated	blattriger
fibrous	fasriger
Chrytallized lamellar gyps. Selenite of some	Fraueneis

VII. or Barytic Genus

Witherite	
Heavy spar. baryt	Schwerspath
earthy	————erde
compact	dichter
granular	kærniger
curved lamellar	krummsh aaliger
straight lamellar	geradshaaliger
not decomposed	frischer
decomposed	mulmiger
columnar	stangenspath
fibrous	fasriger
bolognian spar	bologneserspath
*prismatic baryt	saulen schwerspath

VIII. or Strontian Genus.

Strontianite
Cæles.ine

SECOND CLASS.

Salts	Salze

I Genus, or Sulphats.

Native vitriol alum	naturalicher
capillary salt	haarsalz
Rock butter	bergbutter
Epsom salt	bittersalz
Glauber's salt	glauber

II Genus, or Nitrats.

Native nitre

III. Genus, or Muriats.

Rock salt	Steinsalz
lamellar or foliated	blattriger
fibrous	fasriger
Sea salt	seesalz

IV. Genus, or Carbonats.

Native soda	Naturaliches mineral alkali

THIRD CLASS.

Inflammable fossils	*Brennliche fossilien*

I Genus, or Sulphur.

Native sulphur	Naturalich. schwefel
common	gemeiner
volcanic	vulcanischer

II. Genus, or Bitumens.

Bituminous wood	Bituminoeses holz
common	gemeiner
earthy	erdz
Stone coal	Steinkohle
brown	braun
moor	moor
pitch	pech
glance	glanz
columnar	stangen
slate	schiefer
kennel	kennel

foliated	blatter
coarse	grob
Mineral charcoal	Mineralisches holzkohle
oil	erdoel
pitch	erdpech
elastic	elastiches
earthy	erdiges
slaggy	schlackiger
Amber	Bernstein
white	weisser
yellow	gelber
Honey stone	Honigstein

III OR GRAPHITE GENUS.

Graphite	Graphit
*scaly	schuppiger
*compact	dichter
Coal blende	Kohlenblende

FOURTH CLASS.

Metallic Fossils.

I. GENUS PLATINA.

Native platina	Gediegen platina

II. OR GOLD GENUS.

Native gold	Gediegen gold
gold yellow	goldgelbes
brass yellow	messingelbes
greyish yellow	graugelbes
Nagyag	nagiagerz
Graphic	schrifterz

III. QUICKSILVER GENUS.

Native quicksilver	Gediegenes
Natural amalgam	Naturaliches
*fluid	flussiges
*solid	festes
Corneous ore	Hornerz
Hepatic ore	Lebererz
compact	dichtes
slaty	schiefriges
Cinnabar	Zinnobar
dark red common	dunkel rother
bright red fibrous	hoch rother

IV SILVER GENUS.

Native silver	Gediegenes
*common	gemeiner
*goldish	giltiges
Antimonial silver	Spiesglas
Arsenical silver	Arsenik
Bismuthal	Wismuthisches
Corneous ore	Hornerz
common	gemeiner
earthy	erdiges
Black silver	Schwartze
Glance silver	Glazerze
brittle	sproed
Red silver ore	Roth giltigerz
dark	dunkles
light	lichtes
White silver ore	Weissgiltigerz
Black silver ore	Schwartzgiltigerz
*Grey silver ore	Graugiltigerz

V OR COPPER GENUS.

Native copper	Gediegen
vitreous	Kupferglas
compact	dichter
foliated	blattriger
Variegated ore	Bunterz
Copper pyrites	Kupferkies
White copper ore	Weisserz
Grey copper ore	Fahlerz
Black copper	Schwartze
Red copper ore	Rotherz
compact	dichtes
foliated	blattriges
capillary	haarformiges
Tile ore	Ziegelerz
earthy	erdiges
indurated	verhærtetes
Copper azure	Kupferlazur
earthy	erdiges
radiated	strahlige
Malachite	Malachit
fibrous	fasriger
compact	dichter
Copper green	Kupfergrun
Iron shot copper green	Eisenschussiges
earthy	erdiges
slaggy	shlackiges
Olivine ore	Olivinerz
* Copper mica	Kupferglimmer
* Copper emerald	Kupferschmaragd

VI OR IRON GENUS.

Native iron	Gediegenes
Iron pyrites	Schwefelkies
common	gemeiner
radiated	strahl
hepatic	leber
capilary	haar
*magnetic	magnet
Magnetic iron stone	Magneteisenstein
compact (common)	gemeiner
iron sand	eisensand
Iron glance (Specular)	Eisenglanz
common	gemeiner
compact	dichter
foliated	blattriger
micaceous	eisenglimmer

Red iron stone	Rotheisenstein
red iron froth	rothereisen-rahm
red iron ochre	ochriger
compact	dichter
red hematite	glasskopf
Brown iron stone	Brauneisenstein
brown ochre	brauneokker
*frothy	eisenrahm
ochry	ockriger
compact	dichter
hematitic	glasskopf
Sparry ironstone	Spatheisenstein
Black ironstone	Schwarts
compact	dichter
*hematitic	glasskopf
Clay ironstone	Thon eisenstein
reddle	roethel
columnar	stanglicher
granular	koerniger
*lenticular	lisenformiges
*jaspery	jaspisartiges
common	gemeiner
kidney	eisenneire
pea ore	bohnerz
Bog ore	Raseneisenstein
morass	morasterz
swamp	sumpterz
meadow	wiesenerz
Blue iron earth	Blaueisenerde
Green iron earth	Gruneisenerde
Emeril†	Schmirgel
VII. or Lead Genus.	
Lead glance	Bleyglantz
common	gemeiner
compact	bleischweif
Blue lead ore	Blau blierz
Brown	Braun
Black	Swarz
White	Weiss
Green	Grun
Red	Roth
Yellow	Gelb
Native vitriol of lead	Naturalicher bleivitriol
Lead earth	Bleierde
coherent	feste
*friable	zerreibliche
VIII. or Tin Genus.	
Tin pyrites	Zinnkies
Tin stone	Zinnstein
Cornish ore	Kornisch zinnerz
IX. or Bismuth Genus.	
Native	Gediegen wismuth

† Omitted by Jameson.

Glance	Glanz
Okkre	Ochre
X. or Zinc Genus.	
Blende	Blende
yellow	gelbe
brown	braun
black	schwarze
Calamine	Galmei
compact	dichter
lamellar	blattriger
XI or Genus Antimony.	
Native	Gediegen Spiesglas
Grey	Grau
compact	dichtes
foliated	blattriges
radiated	strahliges
plumose	federerz
Red	Roth spiesglaserz
White	Weiss
Antimonial ochre	Okker
XII or Cobalt Genus.	
White ore	Weisser speiss-cobalt
Grey	Grauer
Glance	Glanz
Black ochry	Schwartzer erd-kobalt
earthy	Schwartzer kobalt mulm
indurated	schwarz verhoeteer erz
Hard black earthy	
Brown ochre	Braun erd
Yellow ochre	Gelber erd
Red ochre	Roth erd
cobalt crust pulverulent earthy	kobalt beschlag
cobalt bloom radiated	kobalt bluthe
XII. or Nickel Genus.	
Kupfernickel	
Nickel okkre	
XIV. or Manganese Genus.	
Grey ore	Grau braunstein-erz
radiated	strahliges
foliated	blattriges
compact	dichtes
earthy	erdiges
Black	Schwarz
Red	Roth
Garnet ore	Granatformiges braunst

XV. OR MOLYBDENA GENUS.

Molybdæna, Sulphuret of molybdæna	Wasserblei

XVI OR ARSENIC GENUS.

Native	Gediegen arsenic
Arsenical pyrites	Arsenik kies
common	gemeiner
silvery	weisserz
Orpiment, Realgar	Rauschgelb
red	rothes
yellow	gelbes
Native oxide	Naturalicher

XVII OR SCHEELE GENUS.

Tungsten	Schwerstein
Wolfram	Wolfram

XVIII. URAN GENUS.

Pitch earth	Pecherz
Uran mica	Uranglimmer
Uranochre	Urnaoker

XIX. MENACAN OR TITANIUM GENUS.

Menachanite
*Rutile
Nigrine
*Iserine
†Nadelstone

*XX OR SILVAN GENUS.

Native sylvan	Gediegen silvan
Graphic ore	Schristerz
Yellow ore	Weiss silvanerz
Black ore	Nagiakererz.

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† Jameson has not inserted the Nadelstein, nor has Brochant the Rutile or the Iserine.

I have prefixed an asterisk * to the substances inserted from Jameson.

CLASSIFICATION OF ROCKS.

FIRST CLASS.

Primitive rocks. Urgebirgsarten

Granite
Gneiss
Mica slate
Clay slate
- common, flint, whetstone, chlorit, talc — slate

Sienite
- common
- schistose

Porphyry
- clay, greystone, hornstone, pitchstone, obsidian, feldspar — porphyrized

Porphyry slate
Quartz
Primitive limestone
Serpentine
Topas rock

SECOND CLASS.

Transition rocks. Uber gangs gebirgsarten

Transition clay slate
Grauwacke
- shistose

Transition limestone
Hornblende slate
Greenstone
Mandelstone, Amygdaloid

THIRD CLASS.

Secondary rocks, Stratiform rocks — *Floetzgebirgsarten*

Trapp formation
- basalt
- basalt porphyritic
- Grey stone
- basaltic amygdaloid
- wacke
- basalt tufa

Stratified clay slate
- common
- alum-shist

Stratified limestone
- compact
- oolite / roogenstein
- fetid stone
- marle
- bituminous marle-shist

Sandstone
- common
  - siliceous
  - argillaceous
  - marly
  - ferruginous
- breccious

Stone coal
- slate clay
- stone coal
- bituminous shist

Chalk

Gypsum

Rock salt

Ferruginous clay

Clay (letten)

FOURTH CLASS.

Alluvial rocks. *Aufgeschwemmte gebirgsartin*

Sand
- Gravel
- fine sand
- quicksand

Mud

Common clay

Bituminous wood

Fossil wood

Aluminous earth

Tufa (soft friable earth)

FIFTH CLASS.

Volcanic rocks. *Volcanische gebirgsarten* *Aecht vulcanische*

Lava
- vitreous
- compact
- cellular
  - scoriaceous
  - spongifom

Pumice stone

Volcanic ashes
- puzzuolana
- volcanic tufa
- piperino
- terras

Pseudo-volcanic rocks
- laviform earthy scoria
- porcellain jasper
- half burnt clay
- argillaceous iron (scapiforme)

CLASSIFICATION OF THE ABBE HAUY.

Taken from his tableau comparatif des resultats de la cristallographie, et de l'analyse chimique, relativement á la classification des mineraux. Paris 1809.

The Abbè Hauy, classes minerals as follows: which will tend to explain the subsequent table.

1st. Class. Acidiferous substances. In number twenty nine.

1st Order. Simple.
2nd Order With an earthy base.
3rd Order. With an alkaline base.
4th Order. Alkaline-earthy.

2nd. Class. Earthy substances. In number sixty eight.
Comprehending forty two species; sufficiently characterized.
twenty six species; dubious.

3rd Class. Combustible substances, not metallic. In number, nine.
1st Order. Simple.
2nd Order. Compound.

4th Class. Metallic substances. In number eighty.
1st Order. Not oxydable without addition, unless by a very intense heat: also, reducible to a metalline state without addition.
2nd Order. Oxydable and reducible per se or without addition.
3rd Order. Oxydable per se, but not reducible per se.

To the second class, I have annexed the analytical synonimes in the descriptive language which has occurred to me, as capable of improvement, and useful application.

Acide sulfurique
Acide boracique
Chaux carbonatee
Arragonite
Chaux phosphatee
Chaux fluatee
Chaux sulfatee
Chaux anhydro-sulfatee
Chaux nitratee
Chaux arseniatee
Baryte sulfatee
Baryte carbonatee
Strontiane sulfatee
Strontiane carbonatee
Magnesie sulfatee
Magnesie boratee
Magnesie carbonatee

Chaux boratee siliceuse
Silice fluatee alumineuse
Potasse nitratee
Soude sulfatee
Soude muriatee
Soude boratee
Soude carbonatee
Ammoniaque sulfatee
Ammoniaque muriatee
Alumine sulfatee alkaline
Alumine fluatee alkaline
Glauberite

SECONDE CLASSE.

Quartz	Silite
Zircon	Zircosilite
Corindon	Argillosilite or asilite : afesilite
Cymophane	Asicalite
Spinelle,	Amusilite. asimulite
Emeraude	Saglucilite
Euclase	Saglufelite
Grenat	Safelite. sifalite
Amphigene	Salite potalkaline. Sapolite
Idocrase	Sicarfelite
Meionite	. . . . . .
Feld-spath	Salite potalkaline. Sapolite.Sacalite.
Apophyllite	Sicalite potalkaline. Hydrous sicapolite
Triphane	Sacalite potalkaline sacapolite
Axinite	Sacafelite
Tourmaline	Asifelite*
Amphibole	Safecamulite.† Sifecamulite
Pyroxene	Sifecamuralite.‡ Sifemucarlite
Yenite	Fesicalite
Staurotide	Asifecalite
Epidote	Sacafelite.‖

* The Rubellite, Siberite and Rosena stones seem to be Safelites Sodalkaline orSafesolites.

† The Grammatite, and the Baikalite, are Sicamulites and Simucafelites.

‡ The Sahlite is a Sicamufalite.

‖ Comprizes the Zoizite which is a Sacafelite, and Scorza which is a Safecalite.

Hypersthene	Sifemulite
Wernerite	Sacafelite
Paranthine	Sacalite sodalkaline or sacasolite.
Diallage	Sacamulite : Safecamulite*
Gadolinite	Yttriasifelite
Lazulite	Salite sodalkaline, or, Sasodalite
Mesotype	Sacalite† hydrous
Stilbite	Sacalite : hydrous
Laumonite	. . . .
Prehnite	Sacafelite
Chabasie	Sacalite sodalkaline. Sasodacalite.
Analcime	Sacalite sodalkaline. Sasodacalite
Nepheline	Asilite
Harmotome	Sibargilite hydrous
Peridot	Musifelite‡
Mica	Safelite potalkaline. Sapofelite
Pinite	Asifelite. Safalite
Disthene	Asifelite
Dipyre	Sacalite
Asbeste	Simucarlite
Talc	Simulite. Sifamulite potalkaline‖
Macle	. . . . . .

Substances dont la classification est incertain.

Allochroite	Sicalfalite¶
Alumine pure	. . . . . .
Amianthoide	Sifecamulite
Anthophyllite	Safemucalite**
Aplome	Sacafelite††
Bergmannite	. . . .
Diaspore	Argillite hydrous
Feld-spath apyre	Asilite potalkaline. Asipolite
Feld-spath bleu	Asimucalite

---

* Bronzite is a Simufalite.
† Smithson Nich. Jour. No. 134. p. 288. Sasodalite.
‡ Comprises Chrysolite and Olivine.
‖ Earth of Verona, or Zoographic talc.
¶ Melanite also.
** Hypersthene. Sifemulite,
†† Epidote of Arandal, a variety : Safecalite.

Fibrolite	Asifelite
Gabronit	. . . . . .
Jade	Sicafelite sodalkaline. Sisodacafelite
Iolithe. Dichroite	. . . .
Kaneelstein	Sicarfelite
Lazulit de Werner	Amusilite
Latialite	Sacalite potalkaline. Sapocalite
Lepidolite	Salite potalkaline. Sapolite
Melilite	. . . .
Natrolithe	Salite sodalkaline hydrous. Sasodalite
Pierre grasse	Safelite sodalkaline.* Sasofelite
Pseudo-sommite	. . . .
Spath en tables	Sicalite
Spinellane	. . . .
Spinelle zincifere	Zincargillite
Spinthere	. . . .
Talc granuleux et talc glaphique	Safecalite potalkaline. Sapocafelite†

TROISIEME CLASSE.

Soufre
Diamant
Anthracite
Graphite
Bitume
Houille
Jayet
Succin
Mellite

QUATRIEME CLASSE.

Platine natif
Or natif
Argent natif
Argent antimonial
Argent sulfure
Argent antimonie sulfure

* Fettstein of Werner?
† The variety glaphique contains no alkali

Argent carbonate
Argent muriate
Mercure natif
Mercure argental
Mercure sulfure
Mercure muriate
Plomb natif
Plumb sulfure
Plomb oxyde rouge
Plomb arsenie
Plomb chromate
Plomb carbonate
Pl. mb molybdate
Plomb phosphate
Plomb sulfate
Nickel natif
Nickel arsenical
Niçkel oxyde
Cuivre natif
Cuivre pyriteux
Cuivre gris
Cuivre sulfure
Cuivre oxydule
Cuivre muriate
Cuivre carbonate bleu
Cuivre carbonate vert
Cuivre arseniate
Cuivre dioptase
Cuivre phosphate
Cuivre sulfate
Fer natif
Fer oxydule
Fer oligiste
Fer arsenical
Fer sulfure
Fer oxyde
Fer phosphate
Fer chromate
Fer arseniate
Fer sulfate
Etain oxyde
Etain sulfure

Zinc oxyde
Zinc carbonate
Zinc sulfure
Zinc sulfate
Bismuth natif
Bismuth sulfure
Bismuth oxyde
Cobalt arsenical
Cobalt gris
Cobalt oxyde noir
Cobalt arseniate
Arsenic natif
Arsenic oxyde
Arsenic sulfure
Manganese oxyde
Manganese sulfure
Manganese phosphate
Antimoine natif
Antimoine sulfure
Antimoine oxyde
Antimoine oxyde sulfure
Urane oxyde
Urane oxydule
Molybdene sulfure
Titane oxyde
Titane anatase
Titane siliceo-calcaire
Scheelin ferrugine
Scheelin calcaire
Tellure natif
Tantale oxyde
Cerium oxyde silicifere

The following classification was suggested by my recollection of a formula of Bergman's, which I have not now by me to refer to, and have no opportunity here of consulting.

The nomenclature is made up, from the names usually employed to designate the earths, viz. silex: argill: calx: muria (magnesia): barytes: strontian: zircon: glucina: yttria: ferrum.

That earth which is in the greatest abundance, is put first; the next in abundance, second; and so on.

Iron is not distinguished from manganese as a component part of stones.

Water gives the denomination of hydrous, when it amounts to ten per cent.

No substance is designated under three per cent: from a presumption, 1st that it may be merely accidental; or 2dly, that it may arise from part of the gangue or strata subjacent and incumbent on the stone; and 3dly. That so small a quantity hardly creates a material difference, especially as so much wider latitude is universally taken without scruple.

To prevent the confusion that might arise from the letter (a) belonging to argill, and the same letter belonging to calx or lime, (ar) is used when argill is in less quantity than lime. When (a) is used precedently to (c) it always designates argill, as more abounding in the stone than lime.

The termination lite., lithos, a stone, is uniformly retained.

Thus, *Silite*, is pure, or nearly pure siliceous earth.

Salite, is a stone composed of silex and argill; the silex predominating.

Asilite, a stone composed of argill and silex, the former predominating.

Simulite, a stone composed of silex and magnesia, the former predominating.

Sicalite, a stone composed of silex and lime, the former predominating.

Sicarlite, a stone composed of silex, lime, and argill, the last in least quantity.

Asicalite, a stone composed of argill, silex and lime, the first predominating.

Sicamarlite, a stone composed of silex, lime, argill, and magnesia. Here the letter a. is used after c. instead of, ar., because there is no room for ambiguity, between the *l.* of calx, and the *l.* of lite. Thus,

Simucalite, denotes silex, magnesia and, lime.

Simucarlite, denotes silex, magnesia, calx, and argill.

Sicamufelite, silex, calx, argill, magnesia, iron.

Casimufelite, calx, argill, silex, magnesia, iron.

Acamusifelite, argill, calx, magnesia, silex, iron.

Musicafelite, magnesia, silex, calx, argill, iron.

Barolite, i. e., pure barytes, does not exist, so far as I know.

Barocalite, barytes with lime.

The alkalies have not yet been found, as the most abundant component part of any stone, and therefore cannot be placed first.

Hence the alkali, is annexed to the name of an alkaliferous stone. Thus, where the alkali is not designated, the stones are alkaline, where it is ascertained thus are potalkaline, or sodalkaline. The Triphane is a sacalite potalkaline, or sacapolite. The Paranthine is a sacalite, sodalkaline, or sacasodalite. The Mesotype is a sacalite hydrous according to Vauquelin and Pelletier, but as Smithson (30 Nich. Jour. 133.) found no lime, and 17 per cent of soda, it will be a Sasolite.

It is presumed the preceding explanations will render the scheme sufficiently intelligible, which I cannot pretend to expose at length, but merely to point out the prominent features, in hopes that some person of more skill than myself, may be tempted to improve upon it.

Upon this plan then, I proceed to arrange mineral substances: which are, either SALINE, EARTHY, INFLAMMABLE or METALLIC.

SALINE substances are ACIDS, viz. the sulphuric, muriatic, and boracic: or ACIDIFEROUS COMPOUNDS, as the carbonats, sulphats, nitrats, muriats, phosphats, fluats, borats, arseniats, tungstats, all which may be properly called, Saloxulites: or, they are ALKALIFEROUS COMPOUNDS, (Salkalites): such as the sulphat of ammonia or Mascagnin, the alkaline sulphat of alum, the alkaline fluat of alum, and the glauberite.

EARTHY substances, are GEOLITES, AGELITES, (or as they might be called synonimously, episunalites) VOLCANOLITES, METEOROLITES.

GEOLITES, or earthy stones, are either *simple geolites*, as containing but one earth. *Binary geolites*, containing two earths. *Ternary geolites*, containing three earths. *Quaternary geolites*, containing four or more earths; and *alkaliferous geolites*, containing alkali.

Simple geolites, are, silites, argillites, calcilites, murilites, barolites, strontilites, glukulites, zircolites, yttrialites.

Binary geolites. Silargilites or salites, sicalcilites or sicalites, simurilites or simulites, sibarolites or sibalites, sistrontilites or sistrolites, &c. &c. where silex is in greatest proportion.

Argillosilites or asilites, argillocalcilites, or acalites, argillomurilites or amulites, &c. where argill predominates.

So musilites, muralites, mucalities &c. where magnesia most abounds.

Ternary geolites, as sicarlites, sacalites, samulites, sicamulites &c.

Quaternary geolites, as asicamurilite, i. e. argill, silex, calx, magnesia: ascamfelite, the same stone with iron &c.

Alkaliferous geolites, or Natrolites. In this class will be included, the stones called, amphigene, feldspar, apophyllite, triphane, paranthine, lazulite, mesotype, chabasie, mica, talc, jade, latialite, lepidolite, natrolite, and Mr. Smithson's late analysis of mesotype, would almost lead us to suspect the zeolites generally, as alkaliferous.

AGELITES or aggregated stones, are binary, ternary, quaternary.

Binary Agelites, as quartz, with mica—quartz with schorl—quartz with hornblende—quartz with feldspar—micaceous feldspars, greenstones, porphyries, pudding stones or breccias, such as the calcareous breccia, the siliceous breccia, the argillaceous breccia, the grauwacke breccia &c.

Ternary Agelites, as granite, sienite, gneiss &c.
Quaternary, as micaceous granit with schorl &c.
VOLCANOLITES, as pumice? obsidian? lava &c.
METEOROLITES.

INFLAMABLE substances: diamond, sulphur plumbago, graphite coal, bituminous coal, mineral oil, jet, asphaltum, amber, mellite.

METALLIC substances: native metalline, oxyds, sulphurets, acidiferous &c.

GEOGNOSY or Geology, (as good a word) will comprehend the ROCKS and SOILS: or natural strata of the earth: which may be conveniently divided into, 1st. primitive rocks, 2dly. transition rocks, 3dly. floetz, stratified or secondary rocks, 4thly. volcanic rocks and soil, 5thly. alluvial soil.

As to these: PRIMITIVE rocks, are so called, because there being no traces of organized matter found in them, they are reasonably supposed to have existed previous to the formation of organized bodies, such as animals and vegetables. These are by Werner, supposed to be formed by chemical precipitation, and chrystallization of their component parts, while these were in a fluid state. This is the *neptunian* or theory of the formation of strata in the *humid* way. The supposition of the strata being raised and placed as we now find them by volcanic operation, is the *plutonian* hypothesis; defended and illustrated by Dr. Hutton and Professor Playfair of Edinburgh, with great knowledge and acuteness.

TRANSITION rocks, are those strata, that seem to have been formed, while the earth was in progress toward a habitable state; and wherein partly by chemical precipitation, and partly by mechanical deposition, the materials of the primitive, and of the secondary rocks appear to be intermingled. These (as in the transition limestone) contain some specimens of organic remains.

The next species of rocks, are called by the English SECONDARY, as being of a formation subsequent to the primitive: by the Germans, FLOETZ, (flœtz-gebirgsarten) the strata not being so abrupt, but tending more to the horizontal structure: by Brochant and the French STRATIFIED rocks. These contain in great abundance comparatively, petrified remains of organic bodies. Kirwan if I rightly recollect, in his geology, states these rocks as not exceeding six thousand feet above the level of the ocean. But *Mont Perdu*, in the Pyrenees, nine thousand feet above that level, is stated to contain numerous organic remains. And the Abbè Don John Ignatius Molina, whose altitudes however are only conjectural, notices the mountain Descabezado, composing a part of the principal chain of the Andes, and *as he thinks*, nearly equal in height to Chimborazo (upwards of 20500 feet English above the ocean) on the top of which many petrified marine productions may be found. I am not yet inclined to give implicit credit to this account.

ALLUVIAL soils, are those, which are made by the late subsidence and chrystallization of earths and salts in water.

VOLCANIC soils, are those, which afford indications.

of their having undergone the action of subterraneous fire.

The particular earths and stones peculiar to each of these divisions, will be more properly sought, in the mineralogical systems of the German and French schools principally the former. I am not yet aware, that Werner's formations, have been accurately traced in this country.

CORRECTIONS AND ADDITIONS.

Page.	Line.	
23	11	add *of*
	14	for *are*, read is.
	last	for *have already mentioned:* read, I shall as-
24	1	sign in the notes.
48	7	for, *supersecde* read, supercede.
58	8	for *Paurge*, read, Panurge.
59	4	for *on*, read, or.
38	7	strike out, Accum.
92	7	strike out than.
	12	add, " for if M. Braconnot's experiment can be depended on, neither carbon nor azot are essentially necessary to explain it, unless indeed they be absorbed from the atmosphere, or formed out of the gasses already mentioned, together with solar light. Recherches sur la force assimilatrice dans les Vegetaux. Ann. de Chimie. 1807. The paper is translated in one of the late volumes of Tilloch or Nicholson.
97	17	for *to*, read, at.
116	14	for *dispite*, read, despite.
121	1	for *stept*, read, step.
123		Vulcan. Add Dr. Stillingfleet in his Origines sacræ l. 3. ch. 5. § 7 is also of opinion that Tubal Cain and Jubal, are Vulcan and Apollo.

Page.	Line.	
137	1	for *stons* read stones.
139		The learned Seldon, in his dissertation De Vitulo aureo, (opera in 6 vol. fol. vol. 2. part 1. page 299) is of opinion it was gilt wood. Aureum hic dico, quod vel ex auro constaret, vel deauratum esset. Page 300 Et aurei illi dicti vituli lignei essent, atque inaurati unde nomen aureorum sortirentur. In Ovid's time the word *aureus* signified any thing gilt. Aurea quæ pendent ornato Signa Theatro, Inspice quam tenuis bractea ligna tegat. Ovid. de Art. am. l. 3. v. 231.
140		for *furmento* in line antepenult, read, the last *frumento*.
148	1	for *discribes*, read, describes.
	15	for, *for*, read, though.
152	13	for *historie*, read, histoire.
158	6	for *impicienda*, read, inspicienda.
161	penult.	for *rulilandis*, read, rutilandis.
163	5	for *Beœtia*, read, Beotia.
170	1	Metaphysics. The best and fairest plan for College Lectures in Metaphysics (if they should be taught at all, which I doubt;) is after Watts's and Duncan's Logic, to read Dr. Dugald Stewart's compendious view of the Tenets of the Scotch school, and the Rev. Mr. Belsham's excellent summary of the doctrines of the English school. Mr. Locke's essay, is too long, and too intricate for a Lecture book, so is Dr. Reids'. As to Dr. Oswald's book, Dr. Beatie's essay on truth, and Dr. Gregory's treatise on necessity, they are beneath further notice. The ignorance of these writers, is only equalled by their presumption. Tho' I would speak with praise both of the arrangement and of the stile of Gregory's CONSPECTUS. If a man would understand any thing on the subject of Metaphysics (and much may be understood) let him first if he can, attend a course of anatomy: and when

Page. Line.

he has carefully perused the physiologies of Haller, Cullen, Blumenbach and Richerand with Darwin's Zoonomia and Crichton on insanity, then and not before, let him read Hartley's great work on man. Great, not in bulk but importance. Having so done, he may be qualified to ask himself what he knows. Dr. Dugald Stewart I observe, in his essays, has dismissed Hartley in a few pages; no slight proof to me that he has read him either with great negligence, or little knowledge. It is very singular that not one author who has attempted to remark on Hartley's theory of vibrations (no essential part of his system) has represented it truly or fairly, not even Dr. Crichton. After this, the student may proceed if he thinks fit, to Hobbes, Leibnitz, Collins, Locke, Priestley, Cooper and Crombie, on one side, and to Jackson, Clarke, Reid, Palmer and Price on the other.

175	4	for *qæuso*, read, quæso.
176	17	for *landatius*, read, laudatius.
181	3	for verbatum read, verbatim.
	14	after *forms*, add ——
185	17	for *conculcate* read, conculcato.

THE END.